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SCIENTIFIC AND TECHNICAL MANPOWER RESOURCES

SUMMARY INFORMATION ON EMPLOYMENT, CHARACTERISTICS, SUPPLY, AND TRAINING

NATIONAL SCIENCE FOUNDATION

NSF 64-28

ERRATA:

Scientific and Technical Manpower Resources

Change numbers on:

Page 135, table V-13

Men's degrees, academic year 1960-61,
All sciences and engineering, from 131,918 to 132,118
Other scientific fields, total, from 54,133 to 54,333
Medicine, from 6,448 to 6,648

Page 139, table V-16

Total degrees, academic year 1957-58,
Engineering, from 5,188 to 5,788
Men's degrees, academic year 1959-60,
All sciences and engineering, from 20,720 to 20,722

Page 144, table V-20

Percents, academic year 1962-63,

From:	100.0	49.1	41.7	7.4	16.0
To:	100.0	50.9	39.0	11.9	18.6

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550

May 1967

MEMO TO ACADEMIC LIBRARIES

In view of the increasing number of requests coming to us for information on scientific and technical personnel, the National Science Foundation is distributing copies of Scientific and Technical Manpower Resources to the libraries of the larger universities and colleges. This publication is the most comprehensive summary of data that the Foundation has issued on the employment, characteristics, education and training, and demand for scientific and technical personnel. It also provides references where further information may be found. We hope you will find this volume a useful reference source.

SCIENTIFIC AND TECHNICAL MANPOWER RESOURCES

SUMMARY INFORMATION ON EMPLOYMENT, CHARACTERISTICS, SUPPLY, AND TRAINING

NATIONAL SCIENCE FOUNDATION

NSF 64–28

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FOREWORD

THE SCIENTIFIC AND TECHNICAL MANPOWER RESOURCES of the United States are among the Nation's basic assets. An adequate supply of highly trained scientists, engineers, and technicians—and the proper utilization of these individuals—is necessary for economic growth and national security. The effective use of scientific and technical personnel requires that accurate data on their supply, training, employment, and other personal and professional characteristics be available to the Government, industry, educators, and the general public. Decisions based on such information cover the full range from an individual student's choice of a career to major national policy determinations affecting research and development priorities.

In recognition of the national need for manpower data, the Congress about 15 years ago included in the legislation establishing the National Science Foundation the stipulation that NSF should provide information about scientific and technical personnel in the United States. The Foundation has carried out this responsibility by collating material from existing sources, coordinating certain data-gathering activities of other Federal agencies, supporting special studies carried out by colleges and universities and other nonprofit organizations, and undertaking studies and surveys directly by NSF's staff, including those of the National Register of Scientific and Technical Personnel. As a result, a large body of information gathered over the past 12 years has become available.

This publication encompasses much of the most recently developed data on scientists, engineers, and technicians in the United States. The report was prepared in the Foundation's Office of Economic and Manpower Studies, Jacob Perlman, Head, under the general guidance of Thomas J. Mills, Head, Manpower and Education Studies Section.

BOWEN C. DEES,
Associate Director (Planning),
National Science Foundation.

NOVEMBER 1964

ACKNOWLEDGMENTS

Norman Seltzer, Associate Study Director, planned and prepared this report in the Manpower Studies Group, Robert W. Cain, Study Director. General staff assistance was provided by Frederick W. Root, Francis Cousins, and Richard J. Petersen, formerly of the Foundation. Christine Capps and Wilma K. Weeks participated in the preparation of statistical materials. Ronald Waring provided editorial assistance and guidance in reviewing the report.

CONTENTS

TEXT

CHARTS

Chapter I – INTRODUCTION

THIS PUBLICATION brings together information from many sources on the personnel who make up the Nation's scientific and technical manpower—their supply, employment, utilization, characteristics, compensation, and education. It is intended to serve both as a source book and as a guide to more detailed information in the various original sources from which the data were drawn. The data in this report were selected as the most appropriate for a clear understanding of the growing body of information dealing with this complex subject. They are the latest available at the time of writing and, when pertinent for showing trends, include statistics for earlier years.

Purpose of Report

Information pertaining to the scientists, engineers, and technicians who perform the multitude of functions necessary to our economic growth and modern technology has become increasingly important to the Government, educational institutions, industry, and the general public. Some of the outstanding problem areas for which information is sought are: *1*) the assurance of an adequate supply of well-trained scientific and technical personnel to meet present and future needs, *2*) the utilization of available scientific and technical manpower to the fullest extent possible, *3*) the improvement of the quality of, as well as an increase in, science and mathematics instruction, and *4*) the need for improving and strengthening the educational system in ways that will permit training of larger numbers of well-qualified scientists and engineers.

The Nation's vital concern about its scientific and technical manpower resources is reflected in the National Science Foundation's programs of scientific manpower studies. More than a decade has elapsed since enactment of the Act which directs the Foundation to ". . . maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States . . . ." This mandate has been interpreted to include the compilation, analysis, and distribution of information on the supply, employment, utilization, demand, characteristics, and training of such personnel.

In 1955 the Foundation issued a publication, *Scientific Personnel Resources*,[1] which was at that time the most comprehensive summarization of data relating to resources of scientific and technical personnel. There were many serious gaps in information, however, and the inadequacies of the data in many areas did not permit meaningful responses to urgent questions dealing with national defense needs, science and technological education, and the furtherance of science itself.

In the next few years, there was mounting pressure to expand systematically the collection of needed statistics on scientists and engineers. As a result, in 1957, the Foundation together with the President's Committee on Scientists and Engineers appointed a special advisory panel, chaired by Dr. Philip M. Hauser of the University of Chicago, to review requirements for scientific manpower data. The panel's findings were issued in a 1958 Foundation report, *A Program for National Information on Scientific and Technical Personnel* (NSF 58–28). The report included recommendations for major areas of scientific manpower data collection and research, and many elements of the Foundation's current programs in these areas were proposed in that publication.

A substantial body of manpower information has now been accumulated through studies and surveys by the National Science Foundation staff or through grants and contracts with other Government agencies, colleges and universities, and independent research organizations. Numerous other Government and non-Government agencies have undertaken manpower studies in their own special areas of interest. These too have added greatly to our knowledge. The present publication brings together as much of this data as practicable.

[1] Washington, D.C. 20402: Supt. of Documents, U.S. Government Printing Office.

Scope and Limitations of Data

This book is concerned primarily with the physical sciences, the life sciences, and engineering, and selectively with the health fields and the social sciences. It should be pointed out that data on manpower in the social sciences are still very limited, whereas information on the other sciences and engineering is now fairly extensive.

Comprehensive information on the health fields is provided by other Federal Government agencies, notably the Department of Health, Education, and Welfare through its National Institutes of Health and Public Health Service.[2] In some instances, when a particular study of scientific and technical personnel obtained information relating to the social sciences or the health fields, it has been included here. The annual Civil Service Commission employment survey of Federal Government white-collar workers is an example of this kind of study. On the other hand, the Bureau of Labor Statistics employment surveys of scientific and technical personnel in industry (the basic source for data in this sector of the economy) are now endeavoring for the first time to obtain data on selected social scientists, and no attempt has been made to provide estimates of them in this report.

Organization of Report

Besides this introductory chapter, the report has been divided into five other chapters. They cover topics of economic background, employment, and characteristics, education, and demand for scientific and engineering personnel.

Chapter II examines certain trends in the economy in order to provide perspective for an evaluation of the multitude of detail on scientific and technical personnel. It covers growth of the economy as reflected by gross national product (GNP), expenditures for research and development (one of the principal factors in demand for scientists and engineers), and expenditures for education (a principal factor in supply). The rest of the chapter discusses trends in population and the labor force, pointing out developments in total population, total labor force, white-collar workers, professional and technical workers, and scientists and engineers.

Chapter III deals with employment of scientists and engineers. It first traces employment in the economy as a whole, as well as in various sectors of the economy, namely, industry, colleges and universities, government (Federal, State, and local), and nonprofit organizations. A special section on the atomic energy field—a unique category—and a brief statement about the military services are included. The remainder of the chapter presents data on utilization in terms of the functions that scientists, engineers, and technicians perform at their places of employment. Information is given here first on scientists and engineers throughout the economy and then on the sectors for which such information is available. A section on scientists and engineers in research and development is included at the end of the chapter.

Chapter IV discusses backgrounds and characteristics of scientists and engineers. Much of the material is drawn from the National Science Foundation's National Register of Scientific and Technical Personnel, which has provided data mainly on scientists and only on a limited number of engineers.[3] Nine characteristics are discussed: employment status, geographic distribution, level of education, age, years of experience, type of employer, type of work activity, foreign language proficiency, and income. The last topic occupies the second half of the chapter and is examined extensively from many aspects.

Chapter V covers education and training in the United States. It begins with a brief description of the size and composition of the educational system—numbers of schools, teachers, and students, with data separated by public and private control, and by elementary, secondary, college, and graduate level of education. Then enrollments and graduates are shown in detail at high school, college, and graduate school levels. The currently critical subject of school dropouts is treated at some length, including material on both high school and college dropouts. In the final sections of the chapter, data from a special Na-

[2] The *Health Manpower Source Book* series, published by the Public Health Service, has been providing detailed manpower data on the various health occupations for a number of years.

[3] A report based on information obtained through the Register is published biennially under the title, *American Science Manpower*. The 1964 National Register will, for the first time, provide information on a nationwide sample of engineers selected from the membership rolls of the major national engineering societies and on selected social scientists.

tional Science Foundation study of college graduates show employment status and relationship of training to occupation.

Chapter VI briefly discusses methods used by Government and non-Government agencies and organizations to estimate short- and long-range demand for scientists and engineers. It provides recent examples of information obtained by these organizations through the use of different approaches analyzing demand in various areas of employment.

Technical notes have been placed at the end of most chapters to clarify and define some of the terminology and classifications. A more detailed and technical discussion of the methodology employed to obtain data and the problems involved may be obtained by referring to the original sources. A bibliography listing the source materials used will also be found at the end of each chapter. General references relating to the various subject matters discussed in all chapters are listed in Appendix A. In Appendix B are listed Government and non-Government agencies and organizations having data-collection programs related to scientific and technical manpower, together with brief descriptions of their activities. An index is provided in appendix C to enable the reader to locate information dealing specifically with any particular subject matter in this report.

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Chapter II—ECONOMIC BACKGROUND AND GROWTH OF SCIENCE AND TECHNOLOGY

THE RAPID GROWTH of science and technology and the concomitant increase in the utilization of scientific and technical manpower in the United States should be reviewed against the background of various economic developments. This chapter presents some pertinent background information relating to the overall growth of the economy, expenditures for scientific research and development, and funds expended for the Nation's educational system. In addition, an analysis of the available trend data on population, labor force, and employment of professional and technical workers provides a framework within which the growth of scientific and engineering manpower may be better understood.

Over the past three decades, the United States has undergone a severe economic depression, been involved in World War II followed by the postwar adjustment of the late 1940's, and has had a series of business cycles in the 1950's and beyond in which temporary periods of economic recession have been succeeded by higher levels of economic activity. Despite these happenings, the Nation's productivity, as measured by the U.S. Department of Labor's index of output of goods and services per man-hour, continued to increase. Since the beginning of the Depression more than 30 years ago, productivity has more than doubled.

Gross National Product

The Nation's economic performance may be evaluated through the use of various measurements. One of the best known overall indicators of economic growth is the gross national product—the total volume of all goods and services produced in the United States as expressed in dollar figures. The trend in the growth of the GNP shows a general upward movement since 1930. By the end of 1960, the total value of all goods and services had increased by $218 billion over the previous decade and reached a level of $585 billion during 1963. (See table II-1.)

TABLE II-1.—*Gross national product, 1930–63*

(Billions of dollars)

Year	Total gross national product	
	In current prices	1963 prices
1963	585. 1	585. 1
1962	554. 9	563. 6
1961	518. 2	531. 2
1960	502. 6	521. 3
1959	482. 7	508. 4
1958	444. 5	476. 7
1957	442. 8	483. 9
1956	419. 2	474. 4
1955	397. 5	464. 9
1954	363. 1	431. 4
1953	365. 4	440. 1
1952	347. 0	420. 8
1951	329. 0	404. 9
1950	284. 6	374. 0
1940	100. 6	242. 0
1930	91. 1	194. 6

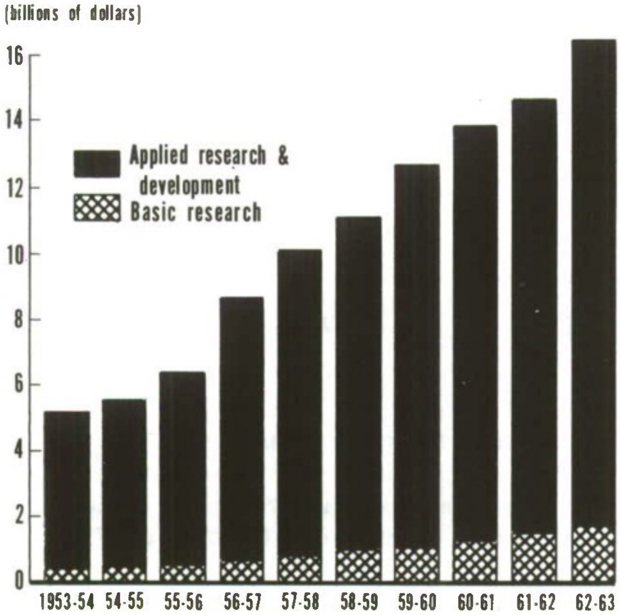
Sources: U.S. Department of Commerce, Office of Business Economics, *Survey of Current Business*, April 1964 and U.S. President, *Economic Report of the President*, 1964 and 1961 issues.

Research and Development Expenditures

One important factor contributing to the economic growth and development of the Nation through its impact on the advancement of science and technology has been the increasing allocation of resources to science and technology, particularly research and development, in all sectors of the economy. Surveys undertaken by the National Science Foundation indicate that in a 10-year period R&D expenditures increased about three times—from about $5 billion in 1953–54 to more than $16 billion during 1962–63. (See table II-2 and chart II-1.) Expenditures for basic research increased from $432 million in 1953–54 to an estimated $1.7 billion in 1962–63. However, the proportion of basic research expenditures in relation to R&D total increased very little—from 8 to 10 percent—during this period.[1] Consistent and

[1] National Science Foundation, *Reviews of Data on Research & Development*, No. 41, "National Trends in R&D Funds, 1953–62," NSF 63-40.

Chart II-1. Trend in total research and development expenditures, 1953–54 to 1962–63



Source: National Science Foundation.

comparable data for scientific expenditures are not available for years before 1953, but it is estimated that just prior to World War II the total annual expenditures for such activities were only slightly more than one-third of a billion dollars,[2] an amount about double that expended a decade earlier in 1930.

The principal source of funds for the support of scientific research and development during the past decade has been the Federal Government. During the years following World War II, Federal expenditures for R&D decreased substantially from a peak in 1944 and 1945 until the early 1950's, when the advent of the Korean War and the continuance of international tensions required much greater support from the Government for defense-related activities. (See table II–3.) By the end of the 1950's Federal expenditures were further increased by costly programs for space activities. The upward trend in expenditures for research and development has continued virtually unaltered over the past decade.

Most of the Federal expenditures help finance R&D activities in private industry. Progressively smaller amounts support performance of R&D in the Government itself and much of the R&D performed by colleges and universities and other nonprofit institutions. The total increase in the funds for R &D performance from 1953–54 to 1962–63 is due primarily to a rise of over 200

[2] Vannevar Bush, *Science, the Endless Frontier*. A report to the President on a program for postwar scientific research, 1945, reprinted, National Science Foundation, 1960.

TABLE II–2.—*Research and development expenditures, 1953–54 to 1962–63*

(Millions of Dollars)

Year [1]	R&D expenditures		
	Total	Basic research	Applied research and development
1962–63 [2]	16, 400	1, 720	14, 680
1961–62 [2]	14, 740	1, 488	13, 252
1960–61	13, 890	1, 256	12, 634
1959–60	12, 680	1, 064	11, 616
1958–59	11, 130	975	10, 155
1957–58	10, 100	834	9, 266
1956–57	8, 670	694	7, 976
1955–56	6, 390	547	5, 843
1954–55	5, 620	485	5, 135
1953–54	5, 150	432	4, 720

[1] Hyphenated years are used because of the wide variety of fiscal, academic, and business years employed by survey respondents in all sectors of the economy. Data represent aggregates for 12-month periods beginning at some time in the earlier year.
[2] Preliminary estimate.

Sources: National Science Foundation, *Reviews of Data on Research & Development*, No. 41, "National Trends in R&D Funds, 1953–62," NSF 63–40, and U.S. President, *Economic Report of the President*, 1964.

TABLE II–3.—*Trend in Federal expenditures for scientific research and development, 1930–63*

(Millions of dollars)

Fiscal year	Total budget expenditures	R&D expenditures [1]
1963 [2]	94, 311	12, 226
1962	87, 787	10, 373
1961	81, 515	9, 278
1960	76, 539	7, 738
1959	80, 342	5, 803
1958	71, 369	4, 990
1957	68, 966	4, 462
1956	66, 224	3, 446
1955	64, 389	3, 308
1954	67, 537	3, 148
1953	74, 120	3, 101
1952	65, 303	1, 816
1951	43, 970	1, 301
1950	39, 544	1, 083
1945	98, 416	1, 591
1940	9, 062	74
1930	3, 183	[3] 69

[1] Includes amounts for conduct of research and development and for R&D plant. Beginning with fiscal year 1953, amounts include pay and allowances of military personnel in research and development.
[2] Preliminary estimate.
[3] Estimate based on unpublished figures.

Sources: National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, Vol. XII, NSF 64–11, except total budget expenditures for 1930, U.S. Department of Commerce, Bureau of the Census, *Statistical Abstract, 1961*.

TABLE II–4.—*Funds for performance of research and development in the United States, by sector, 1953–54 to 1962–63* [1]

Sector	Annual expenditures (in millions of dollars)										Percent increase 1953–54 to 1962–63
	1953–54	1954–55	1955–56	1956–57	1957–58	1958–59	1959–60	1960–61	1961–62	1962–63 [2]	
Total	5, 150	5, 620	6, 390	8, 670	10, 100	11, 130	12, 680	13, 890	14, 740	16, 400	218
Federal agencies	970	950	1, 090	1, 280	1, 440	1, 730	1, 830	1, 900	2, 090	2, 700	178
Industry	3, 630	4, 070	4, 640	6, 600	7, 730	8, 360	9, 610	10, 510	10, 870	11, 600	220
Colleges and universities	450	480	530	650	780	840	1, 000	1, 200	1, 400	1, 700	278
Other nonprofit institutions	100	120	130	140	150	200	240	280	380	400	300

[1] See table II–2, footnote 1.
[2] Preliminary extimates.

NOTE: R&D performance as used here indicates the amount of funds actually expended by a sector in carrying out R&D activities regardless of the source of these funds.

Sources: National Science Foundation, *Reviews of Data on Research & Development*, No. 41, "National Trends in R&D Funds, 1953–62," NSF 63-40; and U.S. President, *Economic Report of the President*, 1964.

percent in the volume of funds—almost $8 billion—used by the industry sector in carrying out research and development activities. (See table II–4.) Each of the other economic sectors shows smaller absolute increases during this period.

Expenditures for research and development in relation to the gross national product serve as one measure of the allocation of the Nation's resources to the advancement of science and technology. An examination of these two economic indicators over a 10-year period shows a steady rise in the proportion of R&D expenditures to total GNP. While R&D expenditures more than tripled between 1953–62, as a percentage of the GNP they more than doubled—from 1.4 percent to nearly 3 percent. (See table II–5.)

Expenditures in the Educational System

The educational system of the Nation is the primary source for training scientific and technical manpower, and therefore of great interest to the National Science Foundation and other Government and non-Government agencies and organizations. The steadily increasing funds expended by the educational system reflect both economic growth and the desire of the Nation to increase the educational attainment of the population. Total expenditures by educational institutions at all levels were $3.2 billion in 1930. They rose $118 million during the 1930's, jumped nearly $6 billion from 1940 to 1950, and by 1960 had further increased more than $15 billion to an estimated level of almost $25 billion. (See table II–6.) Preliminary 1963 estimates indicate still higher total expenditures of about $32 billion.

In publicly controlled institutions, which expended about 80 percent of all educational funds, elementary and secondary school expenditures reached an estimated level of about $19.7 billion, and college and university expenditures about $5.1 billion, in 1963. Total expenditures by both public and private institutions of higher education, estimated at about $9 billion in 1963, were nearly 3½ times the reported expenditures in 1950 and almost 15 times those in 1930. Higher educational institutions currently expend more than 25 percent of all education funds.

Educational expenditures in relation to GNP over the last 30 years indicate that not until the mid-1950's was a definite upward trend established and maintained. (See table II–7.) The amount of funds expended for education rose from a level of 3.3 percent of the GNP in 1930 to a high of 4.5 percent in the early part of that decade and

TABLE II–5.—*Research and development expenditures and gross national product, 1953–54 to 1962–63*

Year [1]	R&D expenditures (in millions of dollars)	R&D expenditures as percent of GNP
1962–63 [2]	16, 420	3. 0
1961–62	14, 740	2. 8
1960–61	13, 890	2. 8
1959–60	12, 680	2. 6
1958–59	11, 130	2. 5
1957–58	10, 100	2. 3
1956–57	8, 670	2. 1
1955–56	6, 390	1. 6
1954–55	6, 620	1. 6
1953–54	5, 150	1. 4

[1] See table II–2, footnote 1.
[2] Preliminary estimate.

Sources: National Science Foundation, *Reviews of Data on Research & Development*, No. 41, "National Trends in R&D Funds, 1953–62," NSF 63-40; and U.S. President, *Economic Report of the President*, 1964.

TABLE II–6.—*Total expenditures in the educational system, by level and control, selected years, 1930–63*
(Millions of dollars)

Academic year ending—	All levels			Elementary and secondary schools		Institutions of higher education	
	Total	Public	Private	Public	Private	Public	Private
1963 [1]	31, 980	24, 760	7, 220	19, 660	3, 300	5, 100	3, 920
1962 [1]	29, 430	22, 870	6, 560	18, 220	2, 980	4, 650	3, 580
1960	24, 722	19, 447	5, 275	15, 694	2, 412	3, 753	2, 864
1958	21, 120	16, 748	4, 371	13, 634	2, 079	3, 114	2, 293
1956	16, 812	13, 352	3, 459	11, 005	1, 627	2, 348	1, 832
1954	13, 950	11, 084	2, 866	9, 172	1, 364	1, 912	1, 502
1952	11, 312	8, 967	2, 345	7, 402	1, 036	1, 565	1, 309
1950	9, 335	7, 312	2, 023	5, 883	790	1, 430	1, 233
1940	3, 352	2, 756	597	2, 364	230	392	367
1930	3, 234	2, 655	578	2, 366	235	289	343

[1] Preliminary estimate.

NOTE: Data include Alaska and Hawaii beginning in 1960.

Source: U.S. Department of Health, Education, and Welfare, *Health Education, and Welfare Trends*, 1963 edition.

then declined slowly to a low point of less than 2 percent during the latter years of World War II. The strong emphasis on the needs of the educational system slowly brought this level up until, in 1962, such expenditures comprised over 5 percent of gross national product. (See chart II–2.)

Population and Labor Force

The growth of scientific and engineering manpower can be gaged in relation to the broader framework of population and labor force trends and to certain changes in employment among the major occupational groups. Total population in the United States increased from 123 million in 1930 to over 180 million in 1960. About half of the total increases took place during the 1950's, with nearly 3 million people a year added to the population in that decade. A closer examination of the increase in population, by different age groups, reveals that the entire 15 to 24-year age group—from which most of the college population is drawn and new entrants come into the labor force—increased by only 2 million persons to a total of 24.5 million in the 30 years since 1930. (See table II–8.)

TABLE II–7.—*Educational expenditures and gross national product, selected years, 1930–62*

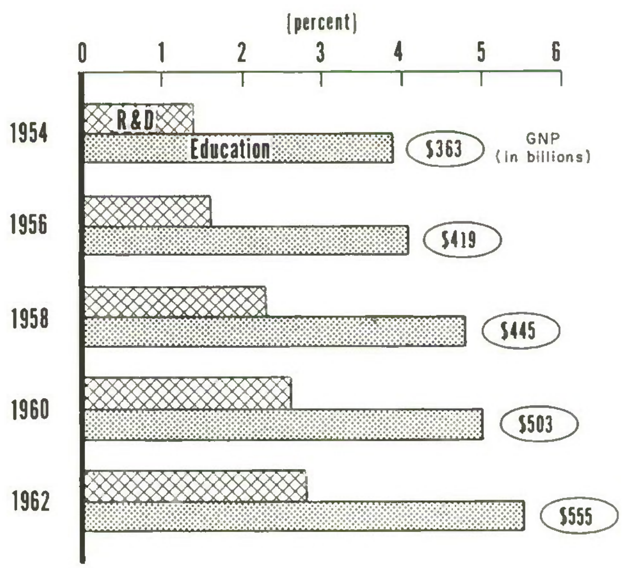
Academic year ending—	Total educational expenditures (in millions of dollars)	Educational expenditures as percent of GNP [1]
1962 [2]	29, 430	5. 5
1960	24, 722	5. 0
1958	21, 120	4. 8
1956	16, 812	4. 1
1954	13, 950	3. 9
1952	11, 312	3. 3
1950	9, 335	3. 5
1940	3, 352	3. 5
1930	3, 234	3. 3

[1] Adjusted to a school-year basis by averaging data for 2 calendar years concerned.
[2] Preliminary estimates.

NOTE: Data include Alaska and Hawaii beginning in 1960.

Source: U.S. Department of Health, Education, and Welfare, *Health, Education, and Welfare Trends*, 1963 edition.

Chart II–2. Expenditures for research and development and education as percent of the gross national product, 1954–62



Sources: National Science Foundation; Department of Health, Education, and Welfare, Office of Education; and Department of Commerce, Office of Business Economics.

TABLE II-8.—*Population of the United States, by age and sex, 1930–60*

(Millions of persons)

Age	Total population				Male				Female			
	1930	1940	1950	1960	1930	1940	1950	1960	1930	1940	1950	1960
Total, all ages	123.1	132.0	151.7	180.7	62.3	66.2	75.5	89.3	60.8	65.8	76.2	91.4
Under 15	36.0	32.9	40.8	56.1	18.2	16.7	20.8	28.5	17.8	16.2	20.0	27.4
15 to 19	11.6	12.3	10.7	13.4	5.8	6.2	5.4	6.8	5.8	6.1	5.3	6.6
20 to 24	10.9	11.6	11.6	11.1	5.4	5.7	5.8	5.6	5.5	5.9	5.8	5.6
25 to 34	19.0	21.4	23.9	22.9	9.5	10.5	11.7	11.3	9.6	10.9	12.2	11.6
35 to 44	17.3	18.4	21.6	24.2	8.8	9.2	10.7	11.9	8.4	9.2	10.9	12.4
45 to 54	13.1	15.6	17.4	20.6	6.8	8.0	8.7	10.1	6.3	7.6	8.7	10.4
55 to 64	8.5	10.7	13.4	15.6	4.4	5.5	6.7	7.6	4.1	5.2	6.7	8.1
65 and over	6.7	9.0	12.3	16.7	3.4	4.4	5.8	7.5	3.3	4.6	6.5	9.1

NOTE: Detail may not add to totals because of rounding.

Sources: U.S. Department of Commerce, Bureau of the Census, *Current Population Reports* (series P-25), No. 114, *Estimates of the Population of the United States, by Age, Color, and Sex, 1900 to 1940;* No. 146, *Estimates of the Population of the United States, by Age, Color, and Sex, July 1, 1950 to 1956;* and No. 246, *Estimates of the Population of the United States, by Age, Color, and Sex, July 1, 1960 and 1961.*

Labor force growth, like that for the population as a whole, was substantial in the 30 years ending in 1960. The number of workers in the labor force increased by nearly half during this period—from 50 million to 73 million. However, in proportion to the total population, the labor force remained at virtually the same level. (See table II–9.)

In addition to absolute growth in population, among the factors tending to increase the number of persons in the labor force have been an increasing participation of women in the labor force and a reduction in the mortality rates. Between 1950 and 1960, when the labor force grew by 8.4 million, women workers accounted for nearly 5 million of this increase. An examination of the age group 20 to 24 years, in which new college-trained entrants into the labor force are usually found, reveals a slight decline for both men and women.

TABLE II-9.—*Total population and labor force growth, 1930–63*

(Millions of persons)

Year	Total population [1]	Labor force
1963	189.3	75.7
1962	186.6	74.7
1961	183.7	74.2
1960	180.7	73.1
1959	177.3	71.9
1958	174.1	71.3
1957	171.2	70.7
1956	168.2	70.4
1955	165.3	68.9
1950	151.7	64.7
1940	132.0	56.2
1930	123.1	50.1

[1] July 1 of each year.

Sources: U.S. Department of Commerce, Bureau of the Census, *Current Population Reports* (series P-25), No. 277, *Estimates of the Population of the United States, January 1, 1950 to November 1, 1963;* No. 250, *Estimates of the Population of the United States and Components of Population Change, 1940 to 1962;* and U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, Vol. 10, No. 8, 1964.

In the key 25-to-44-year age group, there was an increase of 2.5 million, which was accounted for entirely among the workers in ages 35 to 44. This is due primarily to the low birth rates of the 1930's. (See table II–10.)

Growth of the "White-Collar" Population

Comparable information on the composition of the major occupational groups over a long period of time is lacking, although the long-term trends on the numbers of persons in these occupations are considered generally reliable. During the 30 years that the labor force rose about 50 percent, the sector defined as the "white-collar worker group" more than doubled—from more than 14 million to almost 30 million. (See table II–11.)

Clerical workers, the largest segment of the white-collar group in 1930 (30 percent), underwent the greatest growth in both numerical and percentage terms; in 1960 they numbered over 10 million and comprised over 34 percent of all white-collar workers. The major part of this increase was due to the influx of women into clerical positions. Whereas female workers made up slightly more than half of all clerical workers in 1930, by 1960 more than two-thirds of the 10 million clerical workers were women.

Professional and technical workers, in 1960 the second largest white-collar group, increased at

TABLE II–10.—*Labor force in the United States, by age and sex, 1930–60* [1]

(Millions of persons)

Age	Total labor force				Male				Female			
	1930	1940	1950	1960 [2]	1930	1940	1950	1960 [2]	1930	1940	1950	1960 [2]
Total, all ages	47.4	56.2	64.7	73.1	37.0	42.0	46.1	49.5	10.4	14.2	18.7	23.6
14 to 19	4.4	5.0	5.4	6.2	2.8	3.3	3.4	3.8	1.6	1.7	2.0	2.4
20 to 24	7.1	8.4	7.9	7.7	4.7	5.5	5.2	5.1	2.3	2.9	2.7	2.6
25 to 34	11.6	14.0	15.1	15.1	9.1	10.2	11.0	10.9	2.6	3.8	4.1	4.1
35 to 44	10.3	11.6	14.1	16.6	8.4	8.9	10.0	11.3	1.8	2.6	4.2	5.3
45 to 54	7.6	9.3	11.5	14.9	6.4	7.5	8.2	9.6	1.2	1.8	3.3	5.3
55 to 64	4.4	5.6	7.6	9.4	3.8	4.7	5.8	6.4	.6	1.0	1.8	3.0
65 and over	2.0	2.3	3.0	3.2	1.8	2.0	2.5	2.3	.2	.3	.6	.9

[1] Includes persons 14 years of age and over. The 1940–60 data are based on annual averages; the 1930 data are from decennial census, and figures are not strictly comparable with other years; total annual average figure for 1930 estimated to be 50.1 million (table II–9), but breakdown by age and sex not available.
[2] Includes Alaska and Hawaii.

Sources: 1930, John D. Durand, *The Labor Force in the United States, 1890–1960*, Social Science Research Council, 1948; 1940 and 1950, U.S. Department of Commerce, Bureau of the Census, *Current Population Reports* (series P–50), *Annual Report on the Labor Force, 1940 and 1950;* 1960, U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, Vol. 8, No. 5, 1961.

TABLE II–11.—*Economically active white-collar workers in the population, by sex and occupational group, 1930–60*

(Thousands of persons)

Occupational group	1930 [1]			1940 [2]			1950 [2]			1960 [2]		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
White-collar workers	14,320	9,564	4,756	16,082	10,434	5,648	21,601	12,974	8,627	29,506	16,957	12,549
Professional, technical, and kindred workers	3,311	1,829	1,482	3,879	2,271	1,608	5,081	3,074	2,007	7,606	4,852	2,754
Managers, officials and proprietors, except farm	3,614	3,321	292	3,770	3,356	414	5,155	4,456	700	7,165	6,047	1,118
Clerical and kindred workers	4,336	2,090	2,246	4,982	2,282	2,700	7,232	2,730	4,502	10,167	3,277	6,896
Sales workers	3,059	2,323	736	3,450	2,525	925	4,133	2,715	1,418	4,568	2,781	1,787

[1] Civilian gainful workers 10 years old and over.
[2] Persons 14 years old and over in the experienced civilian labor force.

Note: Detail may not add to totals because of rounding.

Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*, D–72–122; and U.S. Department of Labor, Bureau of Labor Statistics, *Special Labor Force Report*, No. 14, "Labor Force and Employment in 1960."

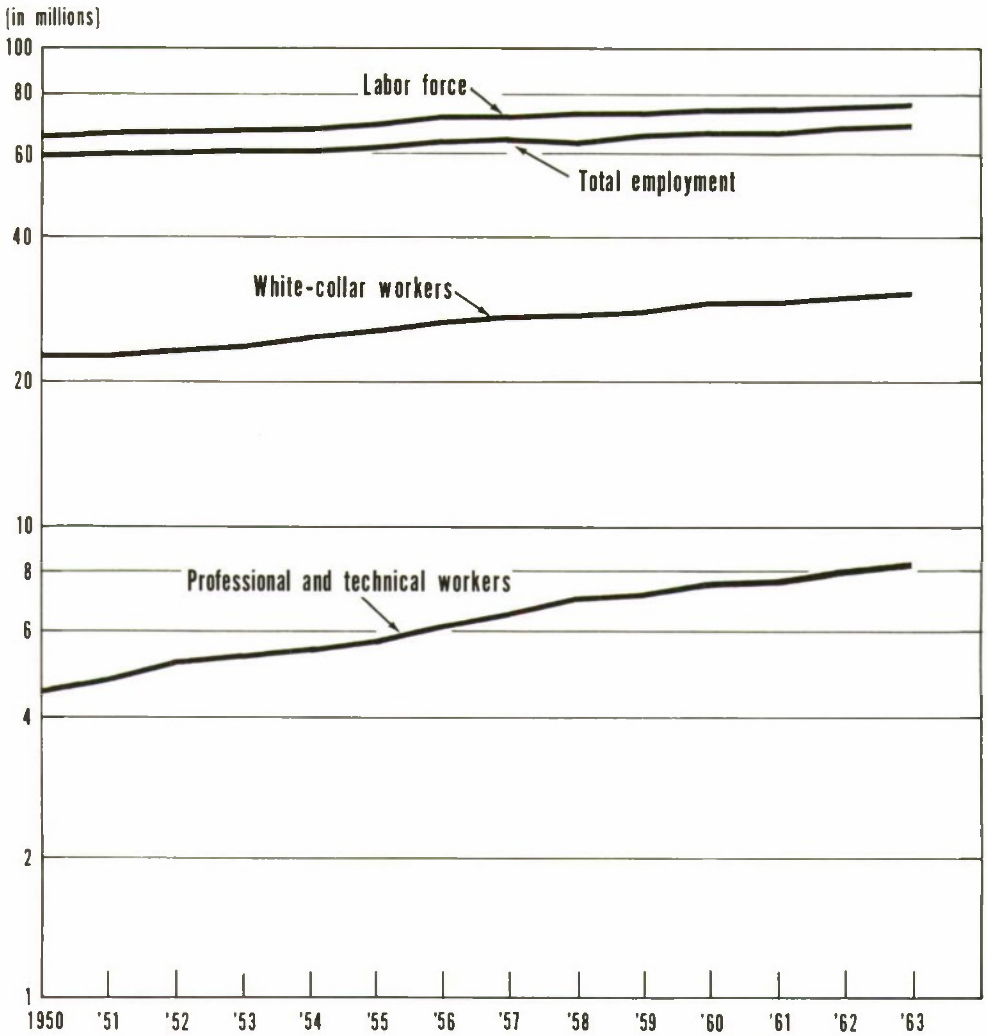
almost the same rate as clerical workers. This important group, which includes workers in scientific and engineering occupations, numbered over 7.6 million in 1960 and comprised more than one-fourth of all white-collar workers. In the professional and technical worker group, male workers increased by 3 million, or from 55 percent to 64 percent of all such workers from 1930 to 1960. (See table II–12.)

Trends in Professional and Technical Employment

Economic growth during the 1950's and early 1960's provided many new job opportunities, and by 1963 total employment had increased 15 percent to 68.8 million. Outstanding during this period was the continued shift from manual to white-collar occupations (professional and technical, managerial, clerical, and sales jobs). About 85 percent of the 9-million increase in total employment was due to the growth of white-collar jobs, and over two-fifths—almost 3.8 million—of these jobs were in professional and technical occupations. (See table II–13 and chart II–3.)

The industrial pattern of the United States continued to change rapidly during the past decade. The growing intricacies of business organizations, the improving and increasingly complex technology, the impact of automation, and the great demand for professional, business, and educational services have stimulated continuous changes in the occupational structure. As indicated in table II–14, employment in professional and technical occupations showed the most rapid growth of all occupational groups—66.5 percent—although clerical and service occupations (excluding household workers) also increased considerably more than average. Manual (blue-collar) occupations ex-

Chart II–3. Labor force, total employment, white-collar workers, and professional and technical workers, 1950–63



Source: Department of Labor, Bureau of Labor Statistics.

panded only slightly (skilled occupations providing most of the 3.7-percent increase), and employment in agriculture continued to decline.

A more detailed examination of employment in several major occupational subgroups within the professional and technical group is available for the years 1957–63. Although data for 1950 are not directly comparable with these other years, since they were obtained on a different basis from the data for the 1957–63 period, an indication of the trend during this period may be observed. Employment in the "other professional and technical" occupation group, which includes scientists, engineers, and technicians (excluding medical), had the largest numerical increase. (See table II–15 and chart II–4.) However, all of the professional and technical groups grew considerably; and in the 1957–63 period, elementary and secondary school teachers showed the highest rate of growth.

Scientific and Engineering Manpower

The estimated total number of scientists and engineers [3] was nearly 1.4 million in 1963—an

[3] See Technical Notes, ch. III for definition of scientists and engineers.

TABLE II-12.—*Percent distribution of economically active white-collar workers in the population, by sex and occupational group, 1930–60*

Occupational group	1930 [1]			1940 [2]			1950 [2]			1960 [2]		
	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female
White-collar workers	100.0	66.8	33.2	100.0	64.9	35.1	100.0	60.1	39.9	100.0	57.5	42.5
Professional, technical, and kindred workers	100.0	55.2	44.8	100.0	58.5	41.5	100.0	60.5	39.5	100.0	63.8	36.2
Managers, officials, and proprietors, except farm	100.0	91.9	8.1	100.0	89.0	11.0	100.0	86.4	13.6	100.0	84.4	15.6
Clerical and kindred workers	100.0	48.2	51.8	100.0	45.8	54.2	100.0	37.7	62.3	100.0	32.2	67.8
Sales workers	100.0	75.9	24.1	100.0	73.2	26.8	100.0	65.7	34.3	100.0	60.9	39.1
White-collar workers	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Professional, technical, and kindred workers	23.1	19.1	31.2	24.1	21.8	28.5	23.5	23.7	23.3	25.8	28.6	21.9
Managers, officials, and proprietors, except farm	25.2	34.7	6.1	23.4	32.1	7.3	23.9	34.3	8.1	24.3	35.7	8.9
Clerical and kindred workers	30.3	21.9	47.2	31.0	21.9	47.8	33.5	21.1	52.2	34.4	19.3	54.9
Sales workers	21.4	24.3	15.5	21.5	24.2	16.4	19.1	20.9	16.4	15.5	16.4	14.3

[1] Civilian gainful workers 10 years old and over.
[2] Persons 14 years old and over in the experienced civilian labor force.

Sources: U.S. Department of Commerce, Bureau of the Census, *Historical Statistics of the United States, Colonial Times to 1957*, D-72-122; and U.S. Department of Labor, Bureau of Labor Statistics, *Special Labor Force Report*, No. 14, "Labor Force and Employment in 1960."

TABLE II-13—*Total employed, white-collar workers, and professional and technical workers, 1950–63*

(Thousands of persons)

Occupational group	1950	1951	1952	1953	1954	1955	1956
Total employed	59,648	60,854	60,989	61,778	61,160	62,997	64,928
White-collar workers [1]	22,373	22,413	23,070	23,614	23,891	24,585	25,597
Professional and technical workers	4,490	4,788	5,092	5,448	5,588	5,792	6,096

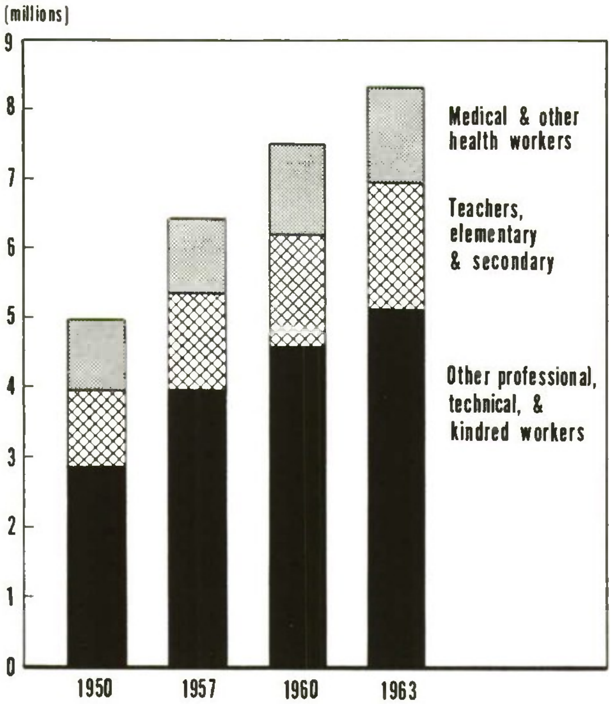
Occupational group	1957	1958	1959	1960	1961	1962	1963
Total employed	65,016	63,966	65,581	66,681	66,796	67,846	68,809
White-collar workers [1]	26,451	27,056	27,798	28,726	29,124	29,901	30,182
Professional and technical workers	6,468	6,961	7,143	7,475	7,705	8,040	8,263

[1] Includes professional, technical, and kindred workers; managers, officials, and proprietors; clerical and kindred workers; and sales workers.

Source: U.S. President, *Manpower Report of the President, and a Report on Manpower Requirements, Resources, Utilization, and Training by the U.S. Department of Labor*, 1964.

increase of about 1.1 million since 1930. Although estimates of the numbers of scientists and engineers are available for the past three decades in selected years, there is no consistent time series for each year of this period. However, an order of magnitude and trend can be observed in these occupations and related to the broader framework of the growth of the labor force and of professional and

Chart II–4. Growth in professional, technical, and kindred workers, selected years, 1950–63



Sources: Department of Labor, Bureau of Labor Statistics and Department of Commerce, Bureau of the Census.

technical workers. (See table II–16 and detailed footnotes.)

Between 1930 and 1960, while the civilian labor force increased by 42 percent and professional and technical workers by 126 percent, the number of engineers rose over 290 percent, and the number of scientists more than 625 percent. In the period from 1954 to 1963, engineers increased by 300,000 and scientists by 210,000—about 46 and 105 percent respectively.

Another index of the striking growth of the engineering profession can be shown in the ratio of engineers to the number of workers in the civilian labor force. In 1930, there were 436 engineers for every 100,000 workers in the civilian labor force; by 1950, there were 861 per 100,000—nearly a twofold increase—and by 1963 the estimated ratio had tripled to 1,302 per 100,000 workers. From a different point of view—number of workers per engineer—the ratio has steadily decreased, although a little more slowly in recent years. This ratio dropped from 230 workers per engineer in 1930 to 77 in 1963. (See table II–17 and chart II–5.)

An additional gross indicator of the increase of scientific and engineering manpower in the United

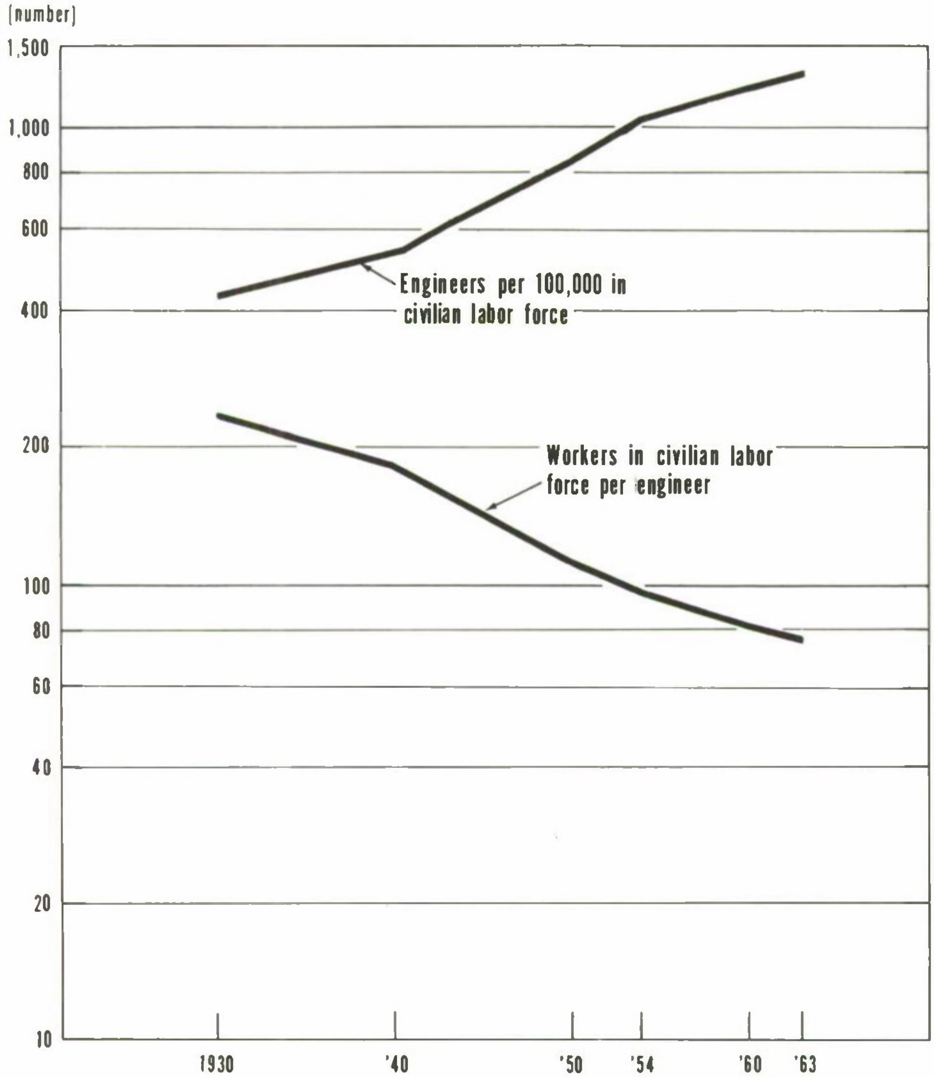
TABLE II–14—*Distribution of employed persons, by major occupational group, 1950 and 1960*

Occupational group	Employment			Percent distribution	
	1950	1960	Percent change 1950–60	1950	1960
	Thousands	*Thousands*			
All occupations	59, 648	66, 681	11. 8	100. 0	100. 0
White-collar workers	22, 373	28, 726	28. 4	37. 5	43. 1
Professional, technical, and kindred workers	4, 490	7, 475	66. 5	7. 5	11. 2
Managers, officials, and proprietors	6, 429	7, 067	9. 9	10. 8	10. 6
Clerical and kindred workers	7, 632	9, 783	28. 2	12. 8	14. 7
Sales workers	3, 822	4, 401	15. 1	6. 4	6. 6
Blue-collar workers	23, 336	24, 211	3. 7	39. 1	36. 3
Craftsmen, foremen, and kindred workers	7, 670	8, 560	11. 6	12. 9	12. 8
Operatives and kindred workers	12, 146	11, 986	−1. 3	20. 3	18. 0
Laborers	3, 520	3, 665	4. 1	5. 9	5. 5
Service workers	6, 535	8, 349	27. 8	11. 0	12. 5
Private household workers	1, 883	2, 216	17. 7	3. 2	3. 3
Service workers, excluding private household	4, 652	6, 133	31. 8	7. 8	9. 2
Agricultural workers	7, 408	5, 395	−27. 2	12. 5	8. 1

NOTE: Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Labor Force, Employment, and Unemployment Statistics, 1947–1961.*

Chart II-5. Growth trend of engineers in relation to labor force, selected years, 1930–63



Sources: National Science Foundation and Department of Labor, Bureau of Labor Statistics.

TABLE II–15.—*Employment of professional, technical, and kindred workers, by major occupational group, 1950 and 1957–63*

(Thousands of persons)

Major occupational group	1950 [1]	1957	1958	1959	1960	1961	1962	1963
Professional, technical, and kindred workers	4,921	6,468	6,961	7,143	7,475	7,705	8,040	8,263
Medical and other health workers	1,008	1,156	1,247	1,240	1,299	1,328	1,353	1,351
Teachers, elementary and secondary	1,042	1,347	1,494	1,500	1,620	1,642	1,713	1,817
Other professional, technical, and kindred workers	2,872	3,967	4,221	4,404	4,555	4,735	4,974	5,095

[1] 1950 data are based on 1950 Census of Population obtained in April 1950; data are not strictly comparable with other years, which reflect annual averages based on data collected at regular intervals over the entire year.

Note: Detail may not add to total because of rounding.

Sources: U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Population, 1960, General Social and Economic Characteristics, United States Summary*, PC (1)-1C; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, Vol. 8, No. 5, 1961; Vol. 10, No. 3, 1963; and Vol. 10, No. 8, 1964.

TABLE II-16.—*Trend in estimated labor force: total employment; professional, technical, and kindred workers; engineers; and scientists, by selected years, 1930–63*

(Thousands of persons)

Year	Labor force [1]		Total employed [1]	Professional, technical, and kindred workers [2]	Engineers [3]	Scientists [4]
	Total	Civilian				
1963	75, 712	72, 975	68, 809	8, 263	950	410
1960	73, 126	70, 612	66, 681	7, 475	850	335
1954	67, 818	64, 468	60, 890	5, 588	650	200
1950	64, 749	63, 099	59, 748	5, 081	543	170
1940	56, 180	55, 640	47, 520	3, 879	297	92
1930	50, 080	49, 820	45, 480	3, 311	217	46

[1] U.S. Department of Labor, Bureau of Labor Statistics, *Employment and Earnings*, Vol. 10, No. 8, 1964.

[2] 1963 (employed workers only), see footnote 1. 1954, 1960 (employed workers only), U.S. Department of Labor, Bureau of Labor Statistics, *Labor Force, Employment, and Unemployment Statistics, 1947–61*. 1930, 1940, 1950 (workers in the experienced civilian labor force), U.S. Department of Commerce, Bureau of the Census, *Occupational Trends in the United States, 1900 to 1950*.

[3] 1963, National Science Foundation preliminary estimate. 1960, National Science Foundation estimate based on decennial census data; see U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Population, 1960, General Social and Economic Characteristics, United States Summary*, PC(1)-1C. 1954, National Science Foundation estimate. 1930, 1940, 1950 (data adjusted to account for those in the decennial census not reporting occupations), U.S. Department of Commerce, Bureau of the Census, *Occupational Trends in the United States, 1900 to 1950*.

[4] Excludes social scientists, all years. 1963, National Science Foundation preliminary estimate. 1960, National Science Foundation, *Scientists, Engineers, and Technicians in the 1960's—Requirements and Supply*, NSF 63-34. 1954, U.S. Office of Defense Mobilization, *Manpower Resources for National Security*, 1954. 1950, National Science Foundation estimate based on decennial census data; see U.S. Department of Commerce, Bureau of the Census, *U.S. Census of Population, 1960, General Social and Economic Characteristics, United States Summary*, PC(1)-1C. 1930, 1940 (includes research engineers in the Federal Government and teaching staff in departments of engineering in colleges and universities; excludes scientists employed by State and local governments, in industry other than those in research laboratories, and in nonprofit organizations), John R. Steelman, *Science and Public Policy*, Vol. IV: *Manpower for Research*, 1947.

NOTE.—The figures for scientists and engineers are approximations chosen from various sources to show an order of magnitude and trend. They are meant to portray a self-consistent set of national totals rather than precise counts and therefore may not agree with figures cited elsewhere for the same years.

TABLE II-17.—*Growth of the engineering profession in an expanding labor force, by selected years, 1930–63*

Year	Labor force [1]		Engineers [3]	Engineers per 100,000 in civilian labor force	Workers in civilian labor force per engineer
	Total	Civilian			
	Thousands	*Thousands*	*Thousands*		
1963	75, 712	72, 975	950	1, 302	77
1960	73, 126	70, 612	850	1, 204	83
1954	67, 818	64, 468	650	1, 008	99
1950	64, 749	63, 099	543	861	116
1940	56, 180	55, 640	297	534	187
1930	50, 080	49, 820	217	436	230

[1] See table II-16, footnote 1.
[3] See table II-16, footnote 3.

States is the growth of the number of professional scientific societies and the trends in membership in such organizations. A 1959 study by the Office of Science Information Service of the National Science Foundation showed 42 national scientific societies at the beginning of the century. This number doubled by 1920 and increased steadily thereafter to 176 in 1959 (including 22 societies devoted to the social sciences). (See table II-18.) Data on membership in many of these societies, by scientific discipline, are available for the three years 1937, 1948, and 1959. Although there is undoubtedly some overlap due to individuals holding membership in more than one society, observations for the three periods of time show some indication of the growth in different scientific areas. (See table II-19.)

TABLE II-18.—*Growth in professional scientific societies, selected years, 1900–59*

Year	Number of societies
1959	176
1940	127
1920	88
1900	42

Source: National Science Foundation, *Dues and Membership in Scientific Societies*, NSF 60-55.

TABLE II-19.—*Trends in total membership in scientific societies*

Discipline	Number [1]			Percent change	
	1937	1948	1959	1937–48	1948–59
Engineering (11 societies)	62, 337	74, 251	228, 651	19. 1	207. 9
Biology (28 societies)	22, 800	35, 265	61, 245	54. 7	73. 7
Chemistry (4 societies)	22, 198	54, 529	93, 505	145. 6	71. 5
Earth science (8 societies)	11, 870	32, 007	65, 738	169. 6	105. 4
Mathematics (3 societies)	5, 990	10, 385	21, 513	73. 4	107. 2
Physics (4 societies)	3, 899	9, 514	22, 381	144. 0	135. 2
Social science (5 societies)	2, 904	4, 276	13, 933	47. 2	225. 8
Psychology (2 societies)	2, 180	5, 134	17, 528	135. 5	241. 4

[1] Membership figures in this table include only those societies for which such information was available for all three years.

Source: National Science Foundation, *Dues and Membership in Scientific Societies*, NSF 60-55.

Technical Notes

Definitions and Concepts

Gross National Product

Generally, the gross national product may be defined as a measure of national output, the market value of final goods and services produced during a given period. National output is reflected both in flows of commodities and services, constituting national product, and in flows of income generated during the production of these items, comprising national income. The gross national product measures, alternatively, the dollar volume of production, expenditures made to purchase this production, and the payments to individuals and institutions for participation in production.

Research and Development Expenditures

R&D expenditures, as defined here, are for the most part only current operating costs—direct and indirect—including the planning and administration of such research and development. It includes research and development performed by industry under Federal production and procurement contracts. In general, major capital items are excluded from the totals, as are routine testing, mapping and surveys, collection of general purpose statistics, and activities concerned primarily with the dissemination of scientific information or the training of scientific manpower.

Federal expenditures include all direct, indirect, incidental, or related costs resulting from or necessary to research, development, and R&D plant, regardless of whether the work is performed by a Federal agency or performed by private individuals or organizations under a contractual arrangement.

Research and Development Defined

Surveys of the National Science Foundation which collect data on R&D expenditures provide respondents with definitions of these activities in order to obtain comparable data.

Basic Research. For the Federal Government, colleges and universities, and other nonprofit institutions sectors, the NSF definition of basic research stresses that such activity is directed toward increase of knowledge in science. It is research in which ". . . the primary aim of the investigator is a fuller knowledge or understanding of the subject under study, rather than a practical application thereof." The definition is somewhat modified for the industry sector, taking account of an individual industrial company's commercial goals, to indicate that basic research projects represent "original investigation for the advancement of scientific knowledge . . . which do not have specific commercial objectives, although they may be in fields of present or potential interest to the reporting company."

Applied Research. The core definition used by the National Science Foundation is summarized in the colleges and universities sector: "Applied research is directed toward practical application of knowledge." As in the case of basic research, the industry definition has been enlarged to take

into account the special needs of industrial organizations: "Research projects which represent investigation directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes. Note that this definition of applied research differs from the definition of basic research chiefly in terms of the objectives of the reporting company."

Development. The survey concept of development is summarized as follows: "Development is the systematic use of scientific knowledge directed toward the production of useful materials, devices, systems or methods, including design and development of prototypes and processes."

Economic Sectors

In obtaining data on R&D expenditures, the National Science Foundation surveys divide the economy into four sectors as follows:

Federal Government—primarily the executive agencies of the Federal Government.

Industry—manufacturing and nonmanufacturing companies (including commercial laboratories and engineering services) and Federal contract research centers administered by such firms.

Colleges and universities—all institutions of higher education. The component parts of the sector are classified as follows: (1) colleges and universities proper, consisting of colleges of liberal arts, schools of arts and sciences, professional schools such as medicine and engineering, affiliated research institutions, hospitals, and like organizations; (2) agricultural experiment stations and associated schools of agriculture; and (3) Federal contract research centers administered by educational institutions.

Other nonprofit institutions—private philanthropic foundations, nonprofit research institutes, voluntary health agencies, professional societies, museums, zoological gardens, botanical gardens, arboretums, and Federal contract research centers administered by nonprofit organizations.

Labor Force

The concept of the labor force in this report is consistent with the definitions used by the Bureau of the Census and the Bureau of Labor Statistics. The civilian labor force comprises the total of all civilians classified as employed or unemployed. Generally, the employed include those working for any time as paid employees, in their own business or profession or on their own farm, as unpaid workers on a farm or business operated by a member of the family, and all those who were not working or looking for work but who had jobs or business from which they were temporarily absent. Unemployed persons comprise primarily all those who did not work at all during the time surveyed and were looking for work, regardless of whether they were eligible for unemployment insurance.

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TABLE III-3.—*Employed scientists and engineers, by economic sector, 1960*

Sector	Scientists and engineers	Engineers	Scientists
Total	1, 157, 300	822, 000	335, 300
Industry:			
Mining	31, 600	19, 100	12, 400
Construction	55, 100	52, 700	2, 400
Manufacturing	613, 500	472, 800	140, 700
Transportation, communications, and other public utilities	61, 500	58, 800	2, 800
Other industries [1]	100, 400	82, 100	18, 200
Government (Federal, State, and local)	170, 100	109, 400	60, 700
Colleges and universities	125, 100	27, 000	98, 100

[1] Miscellaneous business services, medical and dental laboratories, nonprofit organizations, engineering and architectural services, and other nonmanufacturing industries.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Scientists, Engineers, and Technicians in the 1960's—Requirements and Supply*, NSF 63-34.

Employment in Industry

To obtain basic information on the employment of scientific and technical personnel in industry, the U.S. Department of Labor's Bureau of Labor Statistics, with the support of the National Science Foundation, has undertaken annual nationwide surveys since 1958.

The most recently published survey data [1] show that 851,600 scientists and engineers were working in industrial establishments in early 1962. The survey excluded scientists and engineers employed by very small firms outside the scope of the survey, the relatively few self-employed, and personnel employed in firms established after the sample of industrial establishments was developed. These exclusions may account for an additional 20,000 or more scientists and engineers in industry in 1962. (Preliminary unpublished estimates from the 1963 survey indicate that 873,700 scientists and engineers were employed in January 1963.)

Occupations and Industries

Of the 851,600 scientific and engineering personnel actually reported, about 80 percent (685,000) were engineers, nearly 10 percent (82,000) were employed as chemists, and about half of the remaining 85,000 were employed as physicists, geologists and geophysicists, and mathematicians. (See table III-4.)

Personnel classified as technicians who are employed by industry in both direct and indirect support of scientists and engineers have also been included within the scope of the industrial surveys. The 585,000 technicians employed in January 1962 were classified in four major occupational groups, of which engineering and physical science technicians were the largest—numbering about 255,000, or almost 44 percent of the total. Draftsmen made up another 36 percent, and the remainder were medical, agricultural, and biological technicians or were in the miscellaneous group of "unclassified technicians." (See table III-5.)

TABLE III-4.—*Scientists and engineers employed in industry, by occupation, 1962*

Occupation	Number	Percent [1]
Total	851, 600	100. 0
Engineers	684, 600	80. 4
Physical scientists	135, 500	15. 9
Chemists	81, 600	9. 6
Physicists	13, 900	1. 6
Metallurgists	12, 400	1. 5
Geologists and geophysicists	12, 900	1. 5
Mathematicians	14, 700	1. 7
Life scientists	26, 500	3. 1
Biological scientists	10, 200	1. 2
Agricultural scientists	8, 600	1. 0
Medical scientists	7, 700	. 9
Other scientists (unclassified)	5, 000	. 6

[1] Percent computed from unrounded figures.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Of the scientists and engineers employed in 1962, almost three-fifths were in five major industry groups: electrical equipment, transportation equipment, chemicals, machinery, and the service industries (chart III-2). Within these major industry groups, the largest numbers of scientific and engineering personnel were working in aircraft, communication equipment, industrial

[1] See U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

TABLE III-5.—*Technicians employed in industry, by occupation, 1962*

Occupation	Number	Percent
Total	585, 100	100. 0
Draftsmen	212, 600	36. 3
Engineering and physical science technicians	254, 600	43. 5
Medical, agricultural, and biological technicians	16, 900	2. 9
Other technicians (unclassified)	100, 900	17. 2

NOTE.—Detail may not add to totals because of rounding.

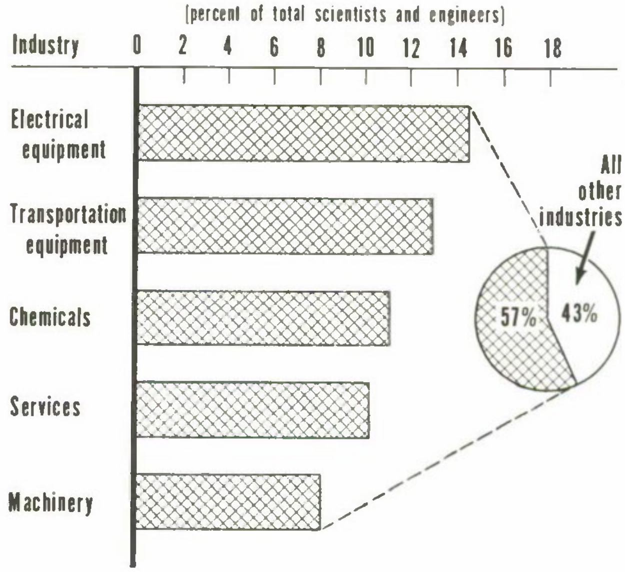
Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

chemicals, and engineering and architectural services. The large-scale research and development activities of companies in these industries and the largely science-based products developed by them account for this heavy concentration of scientists and engineers.

Of the engineers, almost one-third were employed in two manufacturing industry groups—transportation equipment and electrical equipment—with an additional large number employed in the service industries. For the principal scientific occupations, distributions among the industries varied considerably. More than two-fifths of the large number of chemists were employed in the chemical industry group. The drug and pharmaceutical segment of the chemical industry group employed most of the medical scientists (89 percent) and biological scientists (57 percent). Well over one-fourth of the physicists were employed among the electrical equipment industries, almost half of the metallurgists were in the primary metal industry group, and nearly three-fourths of the geologists and geophysicists were employed, as expected, in the petroleum and natural gas extraction and refining industries. Establishments producing food and kindred products employed half of the agricultural scientists. Three industries—aircraft, finance and insurance, and communication equipment—together accounted for nearly two-fifths of the mathematicians. (See table III-6.)

Industry as a whole employed approximately 69 technicians for every 100 scientists and engineers in 1962, although there was a considerable difference between manufacturing and nonmanufacturing industries. For all manufacturing industries combined there were 62 technicians per 100 scientists and engineers, compared with 86 per 100 in nonmanufacturing industries.

Chart III-2. Percent of scientists and engineers employed in five selected industries, 1962



Source: Department of Labor, Bureau of Labor Statistics.

Among the manufacturing industries employing fairly large numbers of scientists and engineers and technicians, the ratios ranged from 98 per 100 in firms concerned with fabricated metal products down to 25 per 100 in the drugs and pharmaceuticals industry. In the 5 industry groups employing the largest numbers of scientists and engineers (electrical equipment, transportation equipment, chemicals, machinery, and services), the technicians ratios varied considerably, from 45 per 100 for chemicals to 120 per 100 for services. (See table III-7.)

The high technicians ratio in the nonmanufacturing industries is due primarily to the much-higher-than-average ratio in the service industries, which employ more than half of the technicians in all nonmanufacturing. The services group reported a ratio of 120 technicians to 100 scientists and engineers. It should be noted, however, that this very high technician ratio in the service industries is in turn heavily influenced by the large

TABLE III-6a.—*Scientists and engineers employed in industry, by industry classification and occupation, 1962*

Industry	Scientists and engineers	Engineers	Chemists	Physicists	Metallurgists	Geologists and geophysicists	Mathematicians	Medical scientists	Agricultural scientists	Biological scientists	Unclassified scientists
Total	851,600	684,600	81,600	13,900	12,400	12,900	14,700	7,700	8,600	10,200	5,000
Manufacturing	613,600	480,300	69,200	11,500	11,100	4,100	9,700	7,300	7,500	8,400	4,700
Ordnance and accessories	39,500	36,900	600	1,000	300	(1)	600	(1)	(1)	100	(1)
Food and kindred products	22,200	10,400	5,300	(1)	(1)	(1)	200	(1)	4,400	500	1,500
Textile mill products	7,000	4,100	2,800	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Lumber and wood products, except furniture	1,600	900	200	(1)	(1)	(1)	(1)	(1)	500	(1)	(1)
Paper and allied products	11,700	7,900	3,200	100	(1)	(1)	100	(1)	500	100	(1)
Chemicals and allied products	95,500	39,200	35,800	1,600	600	300	800	7,100	1,800	7,300	1,100
Industrial chemicals	45,900	26,200	15,600	1,400	400	200	500	100	400	700	300
Plastics and synthetics, except glass	8,200	4,400	3,500	100	(1)	(1)	100	(1)	(1)	100	100
Drugs and pharmaceuticals	21,600	1,600	6,100	(1)	(1)	(1)	100	6,900	700	5,800	300
Agricultural chemicals	2,200	500	1,100	(1)	(1)	(1)	(1)	(1)	500	100	(1)
Other chemical products	17,600	6,400	9,500	100	100	100	100	100	100	700	400
Petroleum refining	20,900	14,100	3,500	200	(1)	2,800	200	(1)	100	(1)	(1)
Rubber and miscellaneous plastics products	7,700	5,800	1,800	100	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Stone, clay, and glass products	9,100	7,500	1,300	200	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Primary metal industries	32,000	22,700	2,800	100	5,900	100	200	(1)	100	(1)	(1)
Blast furnaces and basic steel products	20,200	14,400	1,700	100	3,700	100	200	(1)	100	(1)	(1)
Other primary metal industries	11,800	8,300	1,100	(1)	2,200	(1)	100	(1)	(1)	(1)	(1)
Fabricated metal products	25,100	22,700	1,500	100	500	(1)	200	(1)	(1)	(1)	(1)
Machinery except electrical	69,200	64,000	1,300	800	1,000	100	1,700	(1)	(1)	100	200
Engines and turbines	3,900	3,600	100	(1)	100	(1)	100	(1)	(1)	(1)	(1)
Office, computing, and accounting machines	14,400	11,800	400	500	100	(1)	1,400	(1)	(1)	(1)	100
Farm machinery and equipment	7,400	7,100	100	(1)	200	(1)	(1)	(1)	(1)	(1)	(1)
Other machinery	43,600	41,500	800	300	600	100	200	(1)	(1)	100	(1)
Electrical equipment and supplies	123,200	112,000	3,200	3,900	700	(1)	2,600	(1)	(1)	(1)	700
Electric distribution equipment and industrial apparatus	25,300	23,800	600	400	200	(1)	200	(1)	(1)	(1)	100
Household appliances	3,700	3,500	100	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Communication equipment	55,400	50,500	600	1,900	200	(1)	1,600	(1)	(1)	(1)	600
Electric lighting and wiring equipment	4,200	3,900	100	100	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Electronic components and accessories	18,700	16,000	1,100	900	200	(1)	500	(1)	(1)	(1)	(1)
Radio and television receiving sets	10,800	9,900	200	500	(1)	(1)	200	(1)	(1)	(1)	(1)
Miscellaneous electrical equipment and supplies	5,100	4,500	400	100	100	(1)	(1)	(1)	(1)	(1)	(1)
Transportation equipment	110,400	100,100	2,500	1,900	1,800	200	2,700	(1)	(1)	200	1,000
Motor vehicles and equipment	22,200	20,800	500	200	400	(1)	200	(1)	(1)	(1)	(1)
Aircraft and parts	83,000	74,400	1,900	1,700	1,300	200	2,400	(1)	(1)	200	900
Other transportation equipment	5,100	4,900	100	(1)	(1)	(1)	100	(1)	(1)	(1)	(1)
Instruments and related products	30,200	25,500	2,000	1,400	100	400	400	100	100	100	200
Engineering and scientific instruments	11,500	10,200	300	300	100	400	200	(1)	(1)	(1)	0
Other instruments and related products	18,800	15,300	1,700	1,200	100	(1)	200	100	(1)	100	200
Other manufacturing industries	8,300	6,600	1,500	100	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Nonmanufacturing	238,000	204,300	12,400	2,500	1,300	8,800	5,000	400	1,100	1,800	300
Mining	24,600	15,900	900	(1)	400	7,000	100	(1)	(1)	200	(1)
Metal mining	3,400	2,200	400	(1)	400	400	(1)	(1)	(1)	(1)	(1)
Coal mining	3,100	2,800	300	(1)	(1)	100	(1)	(1)	(1)	(1)	(1)
Crude petroleum and natural gas	16,400	9,500	100	(1)	(1)	6,500	100	(1)	(1)	200	(1)
Quarrying and nonmetallic mining	1,800	1,500	200	(1)	(1)	100	(1)	(1)	(1)	(1)	(1)
Contract construction	41,000	40,700	(1)	(1)	(1)	(1)	200	(1)	(1)	(1)	(1)
Transportation and public utilities	49,200	47,600	500	(1)	(1)	600	300	(1)	200	(1)	(1)
Railroad transportation	5,300	5,000	200	(1)	(1)	(1)	(1)	(1)	100	(1)	(1)
Communication	13,700	13,700	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Electric, gas, and sanitary services	26,000	24,800	300	(1)	(1)	500	300	(1)	100	(1)	(1)
Other transportation	4,200	4,100	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Wholesale and retail trade	31,200	23,500	6,400	200	300	(1)	800	(1)	(1)	(1)	100
Finance, insurance, and real estate	4,500	2,700	(1)	(1)	(1)	(1)	1,600	100	(1)	(1)	100
Services	86,500	73,900	4,500	2,200	600	1,200	1,900	300	(1)	1,600	100
Commercial laboratories; business and management consulting services	34,100	25,800	3,800	1,600	300	400	1,500	300	(1)	300	100
Medical and dental laboratories	700	(1)	200	(1)	(1)	(1)	(1)	100	(1)	400	(1)
Engineering and architectural services	49,800	47,100	400	600	200	800	400	(1)	(1)	100	(1)
Other services	1,800	1,000	100	(1)	(1)	(1)	(1)	(1)	(1)	700	(1)
Agriculture, forestry, and fisheries	1,000	(1)	(1)	(1)	(1)	(1)	(1)	(1)	900	(1)	(1)

[1] Less than 50 cases.
NOTE.—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

TABLE III–6b.—*Percent distribution of scientists and engineers employed in industry, by industry classification and occupation, 1962*

Industry	Scientists and engineers	Engineers	Chemists	Physicists	Metallurgists	Geologists and geophysicists	Mathematicians	Medical scientists	Agricultural scientists	Biological scientists	Unclassified scientists
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Manufacturing	72.1	70.2	84.8	82.3	89.3	31.5	65.9	94.3	86.7	82.3	94.0
Ordnance and accessories	4.6	5.4	.7	6.8	2.7	.1	4.0	.1	(1)	.5	.4
Food and kindred products	2.6	1.5	6.4	.1	(1)	(1)	1.1	.1	50.8	5.1	28.9
Textile mill products	.8	.6	3.5	.1	(1)	(1)	.1	(1)	.1	(1)	(1)
Lumber and wood products, except furniture	.2	.1	.2	(1)	(1)	(1)	(1)	(1)	6.0	(1)	.1
Paper and allied products	1.4	1.1	3.9	.4	(1)	(1)	.5	(1)	5.7	.5	.2
Chemicals and allied products	11.2	5.7	43.9	11.3	4.5	2.4	5.4	91.8	20.7	71.6	22.5
Industrial chemicals	5.4	3.8	19.2	10.0	3.2	1.5	3.5	1.6	4.8	6.8	6.7
Plastics and synthetics, except glass	1.0	.6	4.2	.5	.1	(1)	.5	.1	.3	.6	1.9
Drugs	2.5	.2	7.4	.2	(1)	(1)	.7	89.1	8.5	56.7	6.9
Agricultural chemicals	.3	.1	1.4	(1)	(1)	(1)	(1)	(1)	6.4	.5	(1)
Other chemical products	2.1	.9	11.6	.6	1.1	.8	.8	1.1	.7	6.9	7.1
Petroleum refining	2.5	2.1	4.3	1.3	.2	21.6	1.5	.2	1.2	.4	.5
Rubber and miscellaneous plastics products	.9	.8	2.2	.5	.1	(1)	.2	(1)	(1)	(1)	.5
Stone, clay, and glass products	1.1	1.1	1.6	1.2	.1	.3	.2	(1)	(1)	(1)	.2
Primary metal industries	3.8	3.3	3.5	1.1	47.3	1.0	1.6	.4	1.0	.1	.8
Blast furnaces and basic steel products	2.4	2.1	2.1	.7	29.7	.7	1.0	.2	.8	.1	.6
Other primary metal industries	1.4	1.2	1.4	.3	17.6	.3	.5	.2	.2	(1)	.1
Fabricated metal products	2.9	3.3	1.8	.8	4.3	(1)	1.1	(1)	(1)	.2	(1)
Machinery, except electrical	8.1	9.3	1.6	5.9	8.0	1.0	11.7	.5	.2	.5	3.6
Engines and turbines	.5	.5	.1	.1	.7	(1)	.7	.1	(1)	(1)	(1)
Office, computing, and accounting machines	1.7	1.7	.5	3.7	1.1	(1)	9.5	.3	(1)	(1)	2.4
Farm machinery and equipment	.9	1.0	.1	.1	1.3	(1)	.1	(1)	.2	(1)	.2
Other machinery	5.1	6.1	.9	2.0	4.8	1.0	1.3	.1	(1)	.5	1.
Electrical equipment and supplies	14.5	16.4	3.9	28.2	5.8	.3	17.4	.2	(1)	.3	13.7
Electric distribution equipment and industrial apparatus	3.0	3.5	.8	3.0	1.6	(1)	1.7	(1)	(1)	(1)	1.1
Household appliances	.4	.5	.2	.1	.3	(1)	.1	(1)	(1)	.1	.1
Communication equipment	6.5	7.4	.8	13.6	1.3	.2	11.1	(1)	(1)	.2	11.5
Electric lighting and wiring equipment	.5	.6	.2	.5	.3	(1)	.1	(1)	(1)	(1)	(1)
Electronic components and accessories	2.2	2.3	1.3	6.5	1.5	(1)	3.2	.1	(1)	(1)	.6
Radio and television receiving sets	1.3	1.4	.3	3.9	.3	(1)	1.1	(1)	(1)	(1)	.1
Miscellaneous electrical equipment and supplies	.6	.7	.5	.6	.6	.1	.1	(1)	(1)	(1)	.2
Transportation equipment	13.0	14.6	3.0	13.9	14.8	1.5	18.5	.2	.2	1.8	19.2
Motor vehicles and equipment	2.6	3.0	.6	1.2	3.6	(1)	1.7	(1)	(1)	(1)	.5
Aircraft and parts	9.8	10.9	2.3	12.3	10.9	1.5	16.4	.2	.1	1.8	18.3
Other transportation equipment	.6	.7	.1	.4	.4	(1)	.4	(1)	(1)	(1)	.4
Instruments and related products	3.6	3.7	2.5	10.3	1.1	3.1	2.4	.7	.6	.9	3.3
Engineering and scientific instruments	1.3	1.5	.4	2.0	.7	3.0	1.3	.1	.4	(1)	(1)
Other instruments and related products	2.2	2.2	2.1	8.3	.4	.1	1.2	.7	.2	.9	3.3
Other manufacturing industries	1.0	1.0	1.8	.4	.3	(1)	.2	.1	.2	.2	.3
Nonmanufacturing	27.9	29.8	15.2	17.7	10.7	68.5	34.1	5.7	13.3	17.7	6.0
Mining	2.9	2.3	1.1	.3	3.6	54.4	.7	(1)	.4	1.9	(1)
Metal mining	.4	.3	.5	(1)	3.3	3.1	(1)	(1)	(1)	(1)	(1)
Coal mining	.4	.4	.3	(1)	.1	.7	(1)	(1)	(1)	(1)	(1)
Crude petroleum and natural gas	1.9	1.4	.2	.2	(1)	50.0	.6	(1)	.1	1.8	(1)
Quarrying and nonmetallic mining	.2	.2	.2	(1)	.2	.6	.2	(1)	.2	(1)	(1)
Contract construction	4.8	5.9	(1)	(1)	.1	.4	.3	(1)	(1)	(1)	(1)
Transportation and public utilities	5.8	6.9	.7	.2	.3	4.3	2.1	.1	2.0	.1	.1
Railroad transportation	.6	.7	.2	(1)	.1	.3	.1	(1)	.6	(1)	(1)
Communication	1.6	2.0	(1)	(1)	(1)	(1)	.1	(1)	(1)	(1)	.1
Electric, gas, and sanitary services	3.1	3.6	.4	.1	.1	3.8	1.9	(1)	1.4	(1)	(1)
Other transportation	.5	.6	(1)	(1)	(1)	.2	.1	(1)	(1)	(1)	(1)
Wholesale and retail trade	3.7	3.4	7.8	1.2	2.2	(1)	5.6	(1)	.2	(1)	.9
Finance, insurance, and real estate	.5	.4	(1)	(1)	(1)	.1	11.1	1.2	(1)	(1)	1.1
Services	10.2	10.8	5.6	16.0	4.6	9.4	13.2	4.4	.1	15.7	2.8
Commercial laboratories; business and management consulting services	4.0	3.8	4.7	11.4	2.7	2.9	10.1	.6	.1	3.2	1.8
Medical and dental laboratories	.1	(1)	.3	(1)	(1)	(1)	(1)	.6	(1)	4.2	(1)
Engineering and architectural services	5.9	6.9	.5	4.6	1.9	6.4	3.0	(1)	(1)	1.3	(1)
Other services	.2	.2	.1	(1)	(1)	(1)	.1	(1)	(1)	7.0	(1)
Agriculture, forestry, and fisheries	.1	(1)	(1)	(1)	(1)	(1)	(1)	(1)	10.6	(1)	(1)

[1] Less than 50 cases.
NOTE.—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

number of technicians in engineering and architectural service firms who frequently work under supervision of architects (excluded from the scope of the survey) instead of engineers. Nearly three-fifths of the technicians in the service industries group were employed by these firms.

TABLE III-7.—*Scientists and engineers, technicians, and ratio of technicians to scientists and engineers, by industry classification, 1962*

Industry	Scientists and engineers	Technicians	Average number of technicians per 100 scientists and engineers [1]
Total	851,600	585,100	69
Manufacturing	613,600	379,500	62
Ordnance and accessories	39,500	14,100	36
Food and kindred products	22,200	13,900	63
Textile mill products	7,000	3,700	53
Lumber and wood products, except furniture	1,600	1,900	114
Paper and allied products	11,700	5,700	49
Chemicals and allied products	95,500	43,400	46
Industrial chemicals	45,900	20,800	45
Plastics and synthetics, except glass	8,200	5,400	66
Drugs and pharmaceuticals	21,600	5,400	25
Agricultural chemicals	2,200	1,000	45
Other chemical products	17,600	10,800	61
Petroleum refining	20,900	9,400	45
Rubber and miscellaneous plastics products	7,700	4,700	61
Stone, clay, and glass products	9,100	4,700	52
Primary metal industries	32,000	18,900	59
Blast furnaces and basic steel products	20,200	12,200	60
Other primary metal industries	11,800	6,700	57
Fabricated metal products	25,100	24,600	98
Machinery, except electrical	69,200	63,400	82
Engines and turbines	3,900	3,700	96
Office, computing, and accounting machines	14,400	11,200	78
Farm machinery and equipment	7,400	6,000	81
Other machinery	43,600	42,500	98
Electrical equipment and supplies	123,200	84,900	69
Electric distribution equipment and industrial apparatus	25,300	20,500	81
Household appliances	3,700	2,700	73
Communication equipment	55,400	34,000	61
Electric lighting and wiring equipment	4,200	2,400	57
Electronic components and accessories	18,700	14,200	76
Radio and television receiving sets	10,800	1,100	66
Miscellaneous electrical equipment and supplies	5,100	4,100	80
Transportation equipment	110,400	57,800	52
Motor vehicles and equipment	22,200	15,900	71
Aircraft and parts	83,000	36,300	44
Other transportation equipment	51,000	56,000	110
Instruments and related products	30,200	21,300	71
Engineering and scientific instruments	11,500	8,400	73
Other instruments and related products	18,800	12,900	69
Other manufacturing industries	8,300	7,200	86

TABLE III-7.—*Scientists and engineers, technicians, and ratio of technicians to scientists and engineers, by industry classification, 1962*—Continued

Industry	Scientists and engineers	Technicians	Average number of technicians per 100 scientists and engineers [1]
Nonmanufacturing	238,000	205,500	86
Mining	24,600	10,100	41
Metal mining	3,400	1,100	34
Coal mining	3,100	1,200	39
Crude petroleum and natural gas	16,400	7,100	43
Quarrying and nonmetallic mining	1,800	700	37
Contract construction	41,000	24,600	60
Transportation and public utilities	49,200	44,300	90
Railroad transportation	5,300	3,700	70
Communication	13,700	21,200	154
Electric, gas, and sanitary services	26,000	16,400	63
Other transportation	4,200	3,000	71
Wholesale and retail trade	31,200	18,900	61
Finance, insurance, and real estate	4,500	2,100	47
Services	86,500	103,800	120
Commercial laboratories; business and management consulting services	34,100	36,100	106
Medical and dental laboratories	700	4,100	580
Engineering and architectural services	49,800	60,000	120
Other services	1,800	3,500	192
Agriculture, forestry, and fisheries	1,000	1,700	181

[1] Ratio on unrounded employment figures.

NOTE.—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Recent Trends

Although data obtained from annual employment surveys of scientists and engineers in industry are available as far back as 1958, the results of the surveys are not comparable in all details.[2] However, the overall employment change between 1958 and 1962 can be shown, since each survey collected data on the employment of total scientists and engineers of the preceding year as well as the survey year.

Between January 1958 and January 1960, the number of scientists and engineers increased slightly more than 11 percent—4.6 percent between 1958 and 1959 and about 6.4 percent between 1959 and 1960. About the same rate of increase—6.1 percent—was estimated over the year to January 1961, and a lower rate (4 percent) for the following year to January 1962.

[2] See National Science Foundation reports, *Scientific and Technical Personnel in American Industry—Report on a 1959 Survey*, NSF 60-62, app. B; and *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32, app. B.

TABLE III–8.—*Percent distribution of scientists and engineers employed in industry, by occupation, 1958–62*

Occupation	1958	1959	1960	1961	1962
Total	100.0	100.0	100.0	100.0	100.0
Engineers	80.4	80.5	79.8	79.9	80.4
Physical scientists	16.2	16.2	16.6	16.6	15.9
Chemists	9.5	9.4	9.5	10.1	9.6
Physicists	1.8	2.0	1.9	1.7	1.6
Metallurgists	1.5	1.5	1.6	1.6	1.5
Geologists and geophysicists	2.1	1.9	1.9	1.5	1.5
Mathematicians	1.3	1.5	1.7	1.7	1.7
Life scientists	2.3	2.4	2.4	3.1	3.1
Medical scientists	.9	.9	.8	.9	.9
Agricultural scientists	.7	.7	.7	.8	1.0
Biological scientists	.7	.7	.9	1.3	1.2
Other scientists (unclassified)	1.1	.9	1.1	.4	.6

NOTE.—Detail may not add to totals because of rounding.

Sources: National Science Foundation, *Scientific and Technical Personnel in American Industry—Report on a 1959 Survey*, NSF 60–62; *Scientific and Technical Personnel in Industry, 1960*, NSF 61–75; *Scientific and Technical Personnel in Industry, 1961*, NSF 63–32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Although the reported numbers employed in the scientific and engineering occupations are not entirely comparable (as indicated above) over the span 1958 to 1962, relative changes in the employment patterns are shown. (See table III–8.) These data show very little change in the percent distribution of scientists and engineers in industry—in none of the occupational groups was there as much as 1 percentage-point variation.

Between 1961 and 1962, the 2 most recent years for which comparable occupational data are available, engineers (the largest occupational group) increased about 5 percent. All scientists as a group increased proportionately only about half as much, but the rates and directions of change varied considerably. (See table III–9.) These rates of change among the different occupational groups are subject to measurement problems; for detailed discussion regarding possible underlying factors, refer to the 1960 industry survey report.[3]

Among industries, changes in the employment of scientists and engineers varied considerably, as shown by data covering the 2 years from January 1960 to January 1962. (See table III–10.) Overall, manufacturing employment in both years increased at more than double the rate for nonmanufacturing industries. However, considerable differences in the direction and rate of change occurred in many manufacturing and nonmanufacturing industries. Over the 2-year period, the major employers in manufacturing (electrical equipment, transportation equipment, chemicals, machinery, and ordnance) all showed about average or higher gains.

The highest rates of increase between 1960 and 1961 occurred in the plastics and synthetics industries (30 percent) and in the rubber and miscellaneous plastics products group (27 percent), but both showed lower-than-average increases the following year. For the 1-year period ending in 1962, the highest rates in manufacturing were shown by the electrical equipment industry group (10 percent) and by the fabricated metal products and aircraft and parts industries (8 percent each). In the latter two industries, the rates of increase were less than average the year before.

Among the nonmanufacturing industries employing large numbers of scientists and engineers,

[3] National Science Foundation, *Scientific and Technical Personnel in Industry, 1960*, NSF 61–75, p. 4.

wholesale and retail trade showed a sizable increase for the year ending in January 1961 but declined the following year. Mining showed a slightly higher-than-average increase in 1961–62 but a much lower-than-average the previous

TABLE III–9.—*Scientists and engineers employed in industry, by occupation, 1961 and 1962*

Occupation	Number		Percent change [2]
	January 1961 [1]	January 1962	
Total	814,800	851,600	4.5
Engineers	651,000	684,600	5.2
Physical scientists	134,900	135,500	.5
Chemists	82,100	81,600	−.6
Physicists	14,000	13,900	−.5
Metallurgists	13,000	12,400	−5.0
Geologists and geophysicists	12,100	12,900	6.5
Mathematicians	13,700	14,700	7.4
Life scientists	25,400	26,500	4.3
Medical scientists	7,700	7,700	.2
Agricultural scientists	6,800	8,600	26.6
Biological scientists	10,900	10,200	−6.6
Other scientists (unclassified)	3,600	5,000	41.7

[1] Total for 1961 is based on the 1961 industry survey and differs from the adjusted total for 1961 as derived from the 1962 survey. Occupational detail on adjusted basis for 1961 not collected in the 1962 survey.

[2] Computed from unrounded figures. Percent change for total differs from the total shown in table III–10 for reasons cited in footnote 1.

NOTE.—Detail may not add to totals because of rounding.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63–32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

TABLE III–10.—*Percent change in employment of scientists and engineers in industry, by industry classification, 1960 to 1961 and 1961 to 1962*

Industry	Percent change in year ending—	
	January 1961	January 1962
Total	0.1	p 4.0
Manufacturing	7.2	4.8
Ordnance and accessories	15.1	6.9
Food and kindred products	12.3	5.2
Textile mill products	−.7	−5.0
Lumber and wood products, except furniture	16.2	1.5
Paper and allied products	9.5	3.0
Chemicals and allied products	9.4	2.6

TABLE III–10.—*Percent change in employment of scientists and engineers in industry, by industry classification, 1960 to 1961 and 1961 to 1962*—Continued

Industry	Percent change in year ending—	
	January 1961	January 1962
Industrial chemicals	4.8	−.2
Plastics and synthetics, except glass	30.5	2.4
Drugs and pharmaceuticals	11.9	5.1
Agricultural chemicals	10.3	3.5
Other chemical products	9.6	7.4
Petroleum refining	.4	−1.3
Rubber and miscellaneous plastics products	27.0	2.9
Stone, clay, and glass products	12.9	2.2
Primary metal industries	3.8	1.5
Blast furnaces and basic steel products	3.0	2.0
Other primary metal industries	5.5	.8
Fabricated metal products	4.9	8.4
Machinery, except electrical	7.2	4.6
Engines and turbines	2.4	−.7
Office, computing, and accounting machines	14.7	4.1
Farm machinery and equipment	3.1	2.7
Other machinery	6.3	5.6
Electrical equipment and supplies	8.1	6.3
Electric distribution equipment and industrial apparatus	6.0	1.9
Household appliances	11.0	7.9
Communication equipment	13.3	10.0
Electric lighting and wiring equipment	17.2	7.4
Electronic components and accessories	.6	5.5
Radio and television receiving sets	−4.9	−.7
Miscellaneous electrical equipment and supplies	10.9	8.4
Transportation equipment	3.6	6.6
Motor vehicles and equipment	3.1	2.9
Aircraft and parts	3.7	8.1
Other transportation equipment	5.6	−.3
Instruments and related products	6.9	5.9
Engineering and scientific instruments	11.7	3.8
Other instruments and related products	3.5	7.2
Other manufacturing industries	−1.0	6.7
Nonmanufacturing	3.4	2.0
Mining	1.1	4.4
Metal mining	2.9	−2.5
Coal mining	−4.4	−3.8
Crude petroleum and natural gas	1.3	7.0
Quarrying and nonmetallic mining	2.5	11.3
Contract construction	3.4	−.3
Transportation and public utilities	4.6	3.6
Railroad transportation	−1.8	−.3
Communication	5.0	1.6
Electric, gas, and sanitary services	5.0	4.1
Other transportation	9.1	13.1
Wholesale and retail trade	8.5	−1.0
Finance, insurance, and real estate	11.3	10.6
Services	1.3	2.2
Commercial laboratories; business and management consulting services	4.2	6.1
Medical and dental laboratories	4.4	−.8
Engineering and architectural services	−.9	−2.1
Other services	15.4	109.5
Agriculture, forestry, and fisheries	9.7	21.6

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63–32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

TABLE III-11.—*Scientists and engineers, by industry classification, as percent of total employment in the industry 1961 and 1962*

Industry	January 1961	January 1962
Total	3.0	3.0
Manufacturing	3.9	3.8
Ordnance and accessories	16.9	18.3
Food and kindred products	1.2	1.3
Textile mill products	.7	.8
Lumber and wood products, except furniture	.5	.5
Paper and allied products	2.0	2.0
Chemicals and allied products	10.5	10.2
Industrial chemicals	11.4	11.3
Drugs and pharmaceuticals	16.3	16.9
Other chemical products [1]	7.2	7.0
Petroleum refining	8.1	9.7
Rubber and miscellaneous plastics products	2.1	2.0
Stone, clay, and glass products	2.0	1.9
Primary metal industries	2.8	2.6
Blast furnaces and basic steel products	2.5	2.2
Other primary metal industries	3.7	3.6
Fabricated metal products	2.4	2.2
Machinery, except electrical	4.8	4.6
Office, computing, and accounting machines	8.0	9.5
Other machinery [2]	4.3	4.1
Electrical equipment and supplies	8.2	7.8
Electric distribution equipment and industrial apparatus	7.7	7.4
Household appliances	3.3	2.6
Communication equipment	12.6	12.3
Electronic components and accessories	7.5	7.0
Radio and television receiving sets	8.3	7.8
Miscellaneous electrical equipment and supplies [3]	3.9	3.8
Transportation equipment	7.2	6.8
Motor vehicles and equipment	3.3	3.0
Aircraft and parts	12.1	12.4
Other transportation equipment	2.1	2.4
Instruments and related products	8.3	8.6
Engineering and scientific instruments	14.8	17.7
Other instruments and related products	6.2	6.5
Other manufacturing industries	.2	.3
Nonmanufacturing	1.9	1.9
Mining	4.4	3.8
Metal mining	3.4	4.5
Crude petroleum and natural gas	7.2	5.3
Other mining [4]	1.7	1.9
Contract construction	2.1	2.5
Transportation and public utilities	1.3	1.4
Communication	1.6	1.7
Electric, gas, and sanitary services	4.0	4.2
Other transportation services [5]	.4	.4
Wholesale and retail trade	.9	.8
Finance, insurance, and real estate	.3	.3
Services	6.5	6.4
Commercial laboratories; business and management consulting services	8.3	8.2
Engineering and architectural services	26.7	26.1
Other services [6]	5.7	5.6
Agriculture, forestry, and fisheries	3.7	5.6

[1] Includes plastics and synthetics (except glass) and agricultural chemicals industries.

[2] Includes engines and turbines, and farm machinery and equipment industries.

[3] Includes electric lighting and wiring equipment industry.

[4] Includes coal mining, and quarrying and nonmetallic mining industries.

[5] Includes railroad transportation industry.

[6] Includes medical and dental laboratories.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

year. Engineering and architectural services showed declines both years.

Employment of scientific and technical personnel has increased faster than total employment over the past several years. In all industries combined, there were 25 scientists and engineers for every 1,000 employees in 1958, 27 in 1959, and 28 in 1960. By January 1961 this ratio reached a level of 30 per 1,000 and remained stationary over the next year.

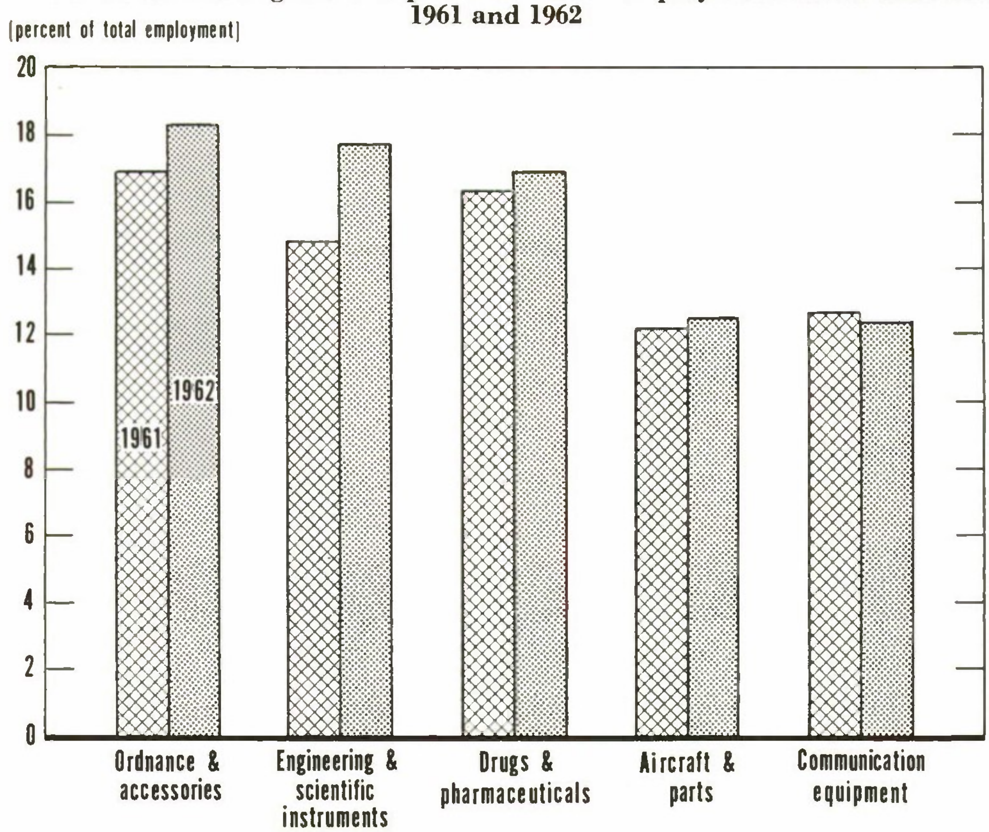
In 1962, five manufacturing industries reported 12 or more percent of their total work force employed as scientists and engineers. The ordnance and accessories industry group had the greatest proportion with more than 18 percent; and the engineering and scientific instruments, drugs and pharmaceuticals, aircraft and parts, and communication equipment industries ranged between 18 and 12 percent (table III-11 and chart III-3). In nonmanufacturing, engineering and architectural services firms had by far the highest ratio of all industries, with 26 percent of all employees reported as scientists or engineers (primarily the latter).

Comparable information on the employment of technicians in industry is also available for several years. Between January 1959 and January 1960, technicians increased about 8 percent, a proportion somewhat higher than reported for scientists and engineers. Over the following year, however, technician employment increased by only 5 percent, and for the 1-year period ending in January 1962 by only 3 percent; in both years the relative increases were smaller than for scientists and engineers.

Estimates of technician employment by various specialties indicate that between 1961 and 1962, medical, agricultural, and biological technicians—the smallest technician group as defined in the industry surveys—had by far the largest relative increase, with 33 percent. The two largest technician groups—draftsmen and the engineering and physical science technicians—grew only about 4 percent, while the large number of unclassified technicians declined (table III-12). It should be noted that the large number of unclassified technicians is probably due to respondents' difficulties in converting position titles to the classification system used in the surveys.[4]

[4] National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32, p. 19.

Chart III-3. Scientists and engineers as percent of total employment in five selected industries, 1961 and 1962



Sources: National Science Foundation and Department of Labor, Bureau of Labor Statistics.

TABLE III-12.—*Technicians employed in industry, by occupation, 1961 and 1962*

Occupation	Number		Percent change [2]
	January 1961 [1]	January 1962	
Total	572, 900	585, 100	2. 1
Draftsmen	204, 200	212, 600	4. 1
Engineering and physical science technicians	244, 600	254, 600	4. 1
Medical, agricultural, and biological technicians	12, 800	16, 900	32. 8
Other technicians (unclassified)	111, 300	100, 900	—9. 4

[1] Data for 1961 are based on the 1961 industry survey and differ from the adjusted figures for 1961 as derived from the 1962 survey. Occupational detail on adjusted basis for 1961 not collected in the 1962 survey.

[2] Computed from unrounded figures. Percent change in the total differs from 2.9 percent total shown in table III-13 for reasons cited in footnote 1.

NOTE.—Detail may not add to totals because of rounding.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32 and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

The changes in employment of technicians among the five principal employing groups in manufacturing (electrical equipment, machinery, transportation equipment, chemicals, and fabricated metal products) varied considerably in the 2-year period from January 1960 to January 1962. The largest proportionate increases among these groups were shown for chemicals in both years, the greatest increase occurring in the plastics and synthetics segment. The engineering and architectural services industry—the largest single employer of technicians in nonmanufacturing—showed a first-year decline, but then an increase over the 2-year period to 1962. (See table III–13.)

Very few industries showed any significant change in the ratio of technicians to scientists and engineers between 1961 and 1962. Among individual industries, the plastics and synthetics and the textile mill products industries in manufacturing and the engineering and architectural services and the communications industries in

TABLE III–13.—*Percent change in employment of technicians in industry, by industry classification, 1960 to 1961 and 1961 to 1962, and ratio of technicians to scientists and engineers, 1961 and 1962*

Industry	Percent change in year ending		Number of technicians per 100 scientists and engineers	
	January 1961	January 1962	January 1961 [1]	January 1962
Total	4.6	2.9	69	69
Manufacturing	6.2	4.5	62	62
Ordnance and accessories	16.4	8.0	35	36
Food and kindred products	18.9	5.0	63	63
Textile mill products	4.3	9.3	46	53
Lumber and wood products, except furniture	−6.5	−1.4	118	114
Paper and allied products	9.5	5.1	48	49
Chemicals and allied products [2]	10.8	9.0	43	46
Industrial chemicals	5.0	1.9	44	45
Plastics and synthetics, except glass	29.4	22.0	55	66
Drugs and pharmaceuticals	14.2	7.0	25	25
Petroleum refining	−2.0	4.5	42	45
Rubber and miscellaneous plastic products	−7.9	7.4	59	61
Stone, clay, and glass products	4.5	3.7	52	52
Primary metal industries [2]	4.6	2.6	58	59
Blast furnaces and basic steel products	.7	5.3	58	60
Fabricated metal products	.5	1.3	105	98
Machinery, except electrical [2]	7.9	4.3	92	92
Office, computing, and accounting machines	13.9	2.6	79	78
Farm machinery and equipment	3.2	5.7	79	81
Electrical equipment and supplies [2]	8.2	5.8	69	69
Electric distribution equipment and industrial apparatus	8.2	4.5	79	81
Communication equipment	10.5	11.6	60	61
Electronic components and accessories	8.8	−3.6	83	76
Radio and television receiving sets	−3.7	5.7	62	66
Transportation equipment [2]	−.7	1.1	55	52
Motor vehicles and equipment	3.3	2.7	72	71
Aircraft and parts	−3.5	1.3	47	44
Instruments and related products	3.0	2.6	73	71
Engineering and scientific instruments	3.5	1.5	75	73
Other instruments and related products	2.6	3.3	72	69
Other manufacturing industries	22.0	5.1	88	86
Nonmanufacturing	1.9	.2	88	86
Mining [2]	−6.8	11.9	39.	41
Crude petroleum and natural gas	−8.4	23.1	38	43
Quarrying and nonmetalic mining	−4.8	5.0	40	37
Contract construction	9.9	−7.4	65	60
Transportation and public utilities [2]	3.5	−.2	94	90
Communication	2.9	8.3	145	154
Electric, gas, and sanitary services	5.5	−5.8	70	63
Wholesale and retail trade	10.0	−4.3	63	61
Finance, insurance, and real estate	−4.2	9.7	48	47
Services [2]	−1.4	2.2	120	120
Commercial laboratories; business and management consulting services	2.9	1.7	111	106
Engineering and architectural services	−3.6	4.2	113	120

[1] Estimates based on adjusted 1961 data obtained in 1962 industry survey.

[2] Total includes individual industries not shown separately.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32; U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

nonmanufacturing showed sizable increases in the ratio. As table III–13 shows, fairly large decreases occurred for fabricated metal products and the electronic components industries in manufacturing and for contract construction in nonmanufacturing—all employing large numbers of scientific and technical personnel.

Scientists and Engineers in Colleges and Universities

A survey of colleges and universities conducted by the National Science Foundation shows that nearly 176,000 scientists and engineers were employed by these institutions in March 1961.[5] Of this number, faculty members accounted for about three-fifths, and about 80 percent of them were employed full time. Graduate students working part time comprised one-fifth of the personnel; the few who held full-time appointments were included with nonfaculty professional personnel. (See table III–14.)

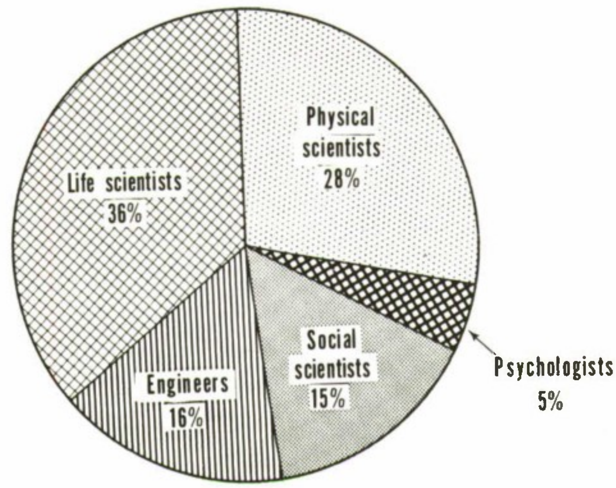
Patterns of Employment

Nearly two-thirds of these science and engineering personnel were employed in the physical and life sciences, and almost one-third were about equally divided between engineering and the social sciences. (See table III–15 and chart III–4.) Of the 108,000 faculty members, more than one-third were in the life sciences, compared with about one-fifth each in the physical and social sciences. Nearly half of the 32,500 nonfaculty personnel (excluding graduate students) were also employed in the life sciences. Almost four-fifths of the 26,900 social science personnel were classified as faculty as were three-fifths of both the 63,200 life scientists and 27,300 engineers. (See table III–16.)

Electrical and mechanical engineers made up nearly half the engineering group and had the greatest proportions employed full time. Chemists were the largest group within the physical sciences, while personnel in the clinical sciences (mainly M.D.'s and D.D.S.'s) made up by far the largest proportion of those in the life sciences. Within the social sciences, the largest single group was the economists. (See table III–17.)

[5] Estimate does not include an additional relatively small number of scientists and engineers (amounting to possibly 5 to 10 percent) employed in institutions not responding to this survey.

Chart III–4. Scientists and engineers employed in colleges and universities, by occupation, 1961



Source: National Science Foundation.

Findings from a 1958 survey conducted by the U.S. Office of Education for the National Science Foundation are presented here to give additional

Table III–14.—*Science and engineering professsional personnel employed in colleges and universities,[1] by type of personnel, 1961*

Type of personnel	Total professional personnel	Full time	Part time	Full time as percent of total
	Number			
Total	175,600	115,000	60,600	66
Faculty members	108,100	87,200	20,900	81
Nonfaculty professional personnel	32,500	27,800	4,700	86
Graduate students [2]	35,000	----------	35,000	----------
	Percent [3]			
Total	100	100	100	----------
Faculty members	62	76	33	----------
Nonfaculty professional personnel	18	24	8	----------
Graduate students [2]	20	----------	58	----------

[1] Includes Federal contract research centers and agricultural experiment stations with their associated colleges of agriculture.

[2] Graduate students who received $100 or more for services performed and were working in a professional capacity. Those holding full-time appointment included with nonfaculty professional personnel.

[3] Computed from unrounded data.

Source: National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4.

TABLE III-15.—*Percent distribution of science and engineering professional personnel employed in colleges and universities,*[1] *by field, 1961*

Field	Total professional employment	Full time	Part time
Total	100	100	100
Engineering	16	16	14
Physical sciences	28	26	31
Life sciences	36	37	34
Social sciences	15	16	14
Psychology	5	5	6

[1] See footnote 1 table III-14.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4.

employment patterns of scientists and engineers in institutions of higher education. These patterns reflect size as well as the basic aims of the various types of institutions.

Distribution of faculty personnel by type of institution in 1958 shows that universities employed about half of the faculty in all fields, although they accounted for fewer than 10 percent of the institutions in the survey. Universities employed almost two-thirds of the faculty members in the natural sciences and engineering, compared with slightly over two-fifths both in the social sciences and in all other fields. The liberal arts colleges were the second largest employers of such personnel. However, technological schools and technical institutes were the only institutions with half or more of their faculty members em_

TABLE III-16.—*Science and engineering professional personnel employed in colleges and universities,*[1] *by type of personnel and field, 1961*

Type of personnel	Total	Engineering	Physical sciences	Life sciences	Social sciences	Psychology
	Number					
Total	175, 600	27, 300	49, 100	63, 200	26, 900	9, 200
Faculty	108, 100	15, 500	26, 700	38, 200	21, 300	6, 400
Nonfaculty professional personnel	32, 500	6, 400	8, 700	15, 400	1, 200	800
Graduate students	35, 000	5, 400	13, 600	9, 600	4, 400	2, 000
	Percent					
Total	100	16	28	36	15	5
Faculty	100	14	25	35	20	6
Nonfaculty professional personnel	100	20	27	47	4	2
Graduate students	100	15	39	27	13	6
Total	100	100	100	100	100	100
Faculty	62	57	54	60	79	70
Nonfaculty professional personnel	19	23	18	24	4	9
Graduate students	20	20	28	15	16	22

[1] See footnote 1, table III-14.

NOTE.—Detail may not add to totals because of rounding.

Source: Data for totals from National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4. Other data on employment by type of personnel and field based on unpublished materials from the 1961 survey which provided data for the report cited.

TABLE III–17.—*Science and engineering professional personnel employed full time and part time in colleges and universities,*[1] *by field, 1961*

Field	Number of professional personnel			Full time as percent of total
	Total	Full time	Part time	
Total	175, 600	115, 000	60, 600	66
Engineering	27, 300	18, 600	8, 700	68
Aeronautical	1, 300	900	400	69
Chemical	2, 400	1, 300	1, 100	54
Civil	3, 800	2, 600	1, 300	68
Electrical	7, 400	5, 300	2, 100	72
Mechanical	6, 000	4, 300	1, 700	72
Other	6, 400	4, 300	2, 100	67
Physical sciences	49, 100	30, 000	19, 100	61
Mathematics	14, 800	9, 500	5, 300	64
Physics	13, 700	8, 300	5, 400	61
Chemistry	15, 700	9, 300	6, 500	59
Earth sciences	3, 900	2, 300	1, 600	59
Other	900	600	300	67
Life sciences	63, 200	42, 600	20, 600	67
Clinical science	23, 400	14, 800	8, 600	63
Commodity related agricultural	8, 800	6, 500	2, 300	74
Biology	6, 100	4, 400	1, 700	72
Botany	3, 600	2, 500	1, 200	69
Other	21, 300	14, 400	6, 800	68
Social sciences	26, 900	18, 500	8, 400	69
Economics	8, 200	5, 500	2, 700	67
Sociology	4, 500	3, 100	1, 500	69
Other	14, 200	9, 900	4, 200	70
Psychology	9, 200	5, 300	3, 900	58

[1] See footnote 1, table III–14.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4.

ployed in the natural sciences and engineering. (See table III–18.)

Nonfaculty personnel were even more highly concentrated than faculty members in universities. Over 90 percent of nonfaculty social science personnel and 86 percent of those in the natural sciences and engineering were employed at such institutions. The high proportions of nonfaculty personnel in the natural science and engineering fields—55 percent at universities and more than 85 percent at technological schools—reflect employment on research projects, located principally in such institutions. (See table III–19.)

In 1958 the concentration of faculty in universities was most evident in the life sciences (75 percent) and engineering (63 percent). Many of them are employed in universities with large, separately organized professional schools of engineering, medicine, agriculture, etc. Liberal arts colleges were the second largest employer group

TABLE III-18.—*Faculty personnel employed at colleges and universities,*[1] *by type of institution and by field, 1958*

Type of institution	Number of institutions	Number of faculty	Percent distribution			
			All fields	Natural sciences and engineering	Social sciences	Other fields
Total	1, 916	211, 100	100. 0	36. 3	11. 1	52. 6
Universities	143	105, 600	100. 0	47. 0	9. 7	43. 3
Liberal arts colleges	730	53, 400	100. 0	22. 5	15. 3	62. 2
Teachers colleges	186	15, 100	100. 0	15. 5	11. 1	73. 4
Technological schools	37	6, 100	100. 0	70. 5	8. 5	21. 0
Theological and religious schools	153	3, 200	100. 0	2. 5	4. 6	92. 9
Junior colleges	500	18, 700	100. 0	25. 3	11. 9	62. 8
Technical institutes	25	1, 100	100. 0	50. 1	6. 2	43. 7
Semiprofessional schools	20	600	100. 0	15. 6	4. 8	79. 6
Other	122	7, 400	100. 0	41. 7	3. 7	54. 6
Total	1, 916	211, 100	100. 0	100. 0	100. 0	100. 0
Universities	143	105, 600	50. 0	64. 7	43. 7	41. 2
Liberal arts colleges	730	53, 400	25. 3	15. 6	35. 1	29. 9
Teachers colleges	186	15, 100	7. 1	3. 0	7. 1	10. 0
Technological schools	37	6, 100	2. 9	5. 6	2. 2	1. 1
Theological and religious schools	153	3, 200	1. 5	. 1	. 6	2. 6
Junior colleges	500	18, 700	8. 9	6. 2	9. 6	10. 6
Technical institutes	25	1, 100	. 5	. 7	. 3	. 4
Semiprofessional schools	20	600	. 3	. 1	. 1	. 4
Other	122	7, 400	3. 5	4. 0	1. 2	3. 7

[1] See footnote 1, table III-14.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Scientific Manpower Bulletin*, No. 13, "Scientists and Engineers Employed at Colleges and Universities, 1958," NSF 61-38, and unpublished data.

in every field except engineering, where technological schools employed a large number of engineering faculty.

Nonfaculty personnel in all the science and engineering fields were employed primarily in universities, including over 90 percent of those in the life and social sciences, 85 percent in the physical sciences, and 70 percent in engineering. The only other type of institution employing sizable numbers of nonfaculty professional personnel in these fields was the technological schools, which accounted for 27 percent of the nonfaculty engineers and nearly 11 percent of the nonfaculty physical scientists. These proportions reflect the research and development activities requiring the services of many nonfaculty scientists and engineers. (See table III-20.)

Recent Trends

Based on data from the 1958 and 1961 surveys of colleges and universities, estimates have been derived for 3 separate years to provide some recent trends in the employment of engineers, physical scientists, and life scientists.

Overall, there was an increase of about 15 percent in these personnel in the 3-year period, although the rate of growth appears to have been somewhat greater between 1960 and 1961. As table III-21 shows, physical scientists, the second largest occupational group, had the largest increase—almost 18 percent—between 1958 and 1960 compared with a very slight increase for life scientists. However, in the 1-year period ending in 1961, the life sciences accounted for more than half of the almost 9,000 total increase.

TABLE III-19.—*Nonfaculty professional personnel employed in colleges and universities,*[1] *by type of institution and by field, 1958*

Type of institution	Number of institutions	Number of nonfaculty [2]	Percent distribution			
			All fields	Natural sciences and engineering	Social sciences	Other fields
Total	1, 916	100, 100	100. 0	51. 3	5. 7	43. 0
Universities	143	80, 000	100. 0	55. 0	6. 5	38. 5
Liberal arts colleges	730	8, 000	100. 0	15. 5	4. 2	80. 3
Teachers colleges	186	1, 600	100. 0	7. 0	3. 0	90. 0
Technological schools	37	5, 600	100. 0	86. 6	1. 5	11. 9
Theological and religious schools	153	500	100. 0	. 6	. 8	98. 6
Junior colleges	500	2, 100	100. 0	8. 8	2. 0	89. 2
Technical institutes	25	200	100. 0	11. 2	----------	89. 8
Semiprofessional schools	20	300	100. 0	6. 5	----------	93. 5
Other	122	1, 800	100. 0	53. 4	. 6	46. 0
Total	1, 916	100, 100	100. 0	100. 0	100. 0	100. 0
Universities	143	80, 000	79. 8	85. 7	90. 5	71. 6
Liberal arts colleges	730	8, 000	8. 0	2. 4	5. 9	14. 9
Teachers colleges	186	1, 600	1. 7	. 2	. 8	3. 5
Technological schools	37	5, 600	5. 6	9. 4	. 1	1. 5
Theological and religious schools	153	500	. 5	(3)	1. 7	1. 1
Junior colleges	500	2, 100	2. 1	. 4	. 7	4. 4
Technical institutes	25	200	. 2	(3)	----------	. 4
Semiprofessional schools	20	300	. 3	(3)	----------	. 6
Other	122	1, 800	1. 8	1. 8	. 2	2. 0

[1] See footnote 1, table III-14.
[2] Includes salaried graduate students.
[3] Less than 0.05 percent.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Scientific Manpower Bulletin*, No. 13, "Scientists and Engineers Employed at Colleges and Universities, 1958," NSF 61-38, and unpublished data.

Employment in the Federal Government

National Science Foundation estimates from data provided by the U.S. Civil Service Commission indicate that about 144,000 scientists and engineers were employed by the Federal Government in October 1962—more than 8 percent of all full-time white collar employees working for the Government. The data cover personnel employed by agencies in the executive, legislative, and judicial branches, except the Central Intelligence Agency and the National Security Agency.

Patterns of Employment

According to the occupational series (or classifications) in which such personnel are classified, the following groups accounted for almost 80 percent of these scientists and engineers: 67,500 engineers, almost 23,700 agricultural and biological scientists, and 23,000 physical scientists. Of the total number of engineers, those classified in civil engineering (18,300) and mechanical engineering (17,300, including over 6,000 in aerospace) accounted for more than half of the personnel in this series. There were also about 14,700 electrical and electronic engineers in the Federal Government. (See table III-22.)

Those working in the agricultural sciences numbered almost 16,500 (over two-thirds employed in soil conservation and forestry), and the biological sciences totaled another 7,200. Within the physical sciences group, chemists accounted for nearly 6,800 persons and physicists another 4,600—together comprising almost half of all personnel in the physical sciences.

Among the almost 15,000 personnel in the health sciences—medical, dental, and veterinary officers—by far the largest number were engaged

TABLE III-20.—*Science and engineering professional personnel employed in colleges and universities,*[1] *by type of institution and field, 1958*

Type of institution	Number of personnel	Percent distribution				
		Total	Engineering	Physical sciences	Life sciences	Social sciences
	Faculty personnel					
Total	100,100	100.0	100.0	100.0	100.0	100.0
Universities	59,900	59.8	62.9	49.0	75.1	43.7
Liberal arts colleges	20,200	20.2	8.1	26.5	11.8	35.1
Teachers colleges	4,000	4.0	.5	5.6	2.4	7.1
Technological schools	4,800	4.8	16.7	6.4	.6	2.2
Theological and religious schools	200	.2	----------	.2	.1	.6
Junior colleges	6,900	6.9	6.8	10.4	3.3	9.6
Technical institutes	600	.6	2.2	.7	.1	.3
Semi-professional schools	100	.1	.4	.1	(2)	.1
Other	400	3.4	2.4	1.1	6.5	1.2
	Nonfaculty personnel [3]					
Total	57,100	100.0	100.0	100.0	100.0	100.0
Universities	49,100	86.1	70.3	84.7	92.0	90.5
Liberal arts colleges	1,600	2.8	1.2	3.7	2.0	5.9
Teachers colleges	200	.3	(2)	.4	.2	.8
Technological schools	4,900	8.6	27.4	10.6	.6	1.7
Theological and religious schools	(2)	(2)	----------	(2)	(2)	.1
Junior colleges	200	.4	.5	.5	.2	.7
Technical institutes	(2)	(2)	.2	(2)	----------	----------
Semi-professional schools	(2)	(2)	.2	(2)	----------	----------
Other	1,000	1.7	.2	(2)	4.0	.2

[1] See footnote 1, table III-14.
[2] Less than 50; less than 0.05 percent.
[3] Includes salaried graduate students.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Scientific Manpower Bulletin* No. 13, "Scientists and Engineers Employed at Colleges and Universities, 1958," NSF 61-38.

TABLE III-21.—*Scientists and engineers employed in colleges and universities,*[1] *by selected fields, 1958, 1960, and 1961*

Field	Number in—			Percent change	
	1958	1960 [2]	1961 [3]	1958–60	1960–61
Total	128,200	137,800	146,600	8.3	6.4
Engineering	25,500	27,500	28,600	7.8	4.0
Physical sciences	40,900	48,100	51,300	17.6	6.7
Life sciences	61,800	62,200	66,700	.6	7.2

[1] See footnote 1, table III-14.
[2] National Science Foundation estimate.
[3] Data include estimate for nonresponse in 1961 survey.

Sources: National Science Foundation, *Scientific Research and Development in Colleges and Universities, Expenditures and Manpower, 1958,* NSF 62-44; and *Reviews of Data on Research & Development,* No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4.

in activities related to "clinical practice," and such personnel are usually excluded from overall counts on the number of scientists.[6] In mathematics and social sciences, there were approximately 5,200 and 5,500 employees, respectively, and the remaining personnel were distributed among the geography and cartography, psychology, and operations research series.

[6] Not included in this report are over 30,000 related professional personnel in the health fields. Data on these additional personnel are included in other NSF reports on Federal Government employment (e.g., *Scientific and Technical Personnel in the Federal Government, 1959 and 1960,* NSF 62-26). These personnel include primarily nurses (over 22,000 in 1962), public health administrators, dieticians, pharmacists, and therapists.

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TABLE III-22.—*Scientists and engineers employed in the Federal Government, by occupational group, October 1962*

Occupational group	Number	Percent
Total	144, 122	100. 0
Physical sciences	23, 043	16. 0
Physics	4, 596	3. 2
Geophysics, geology, and geodesy	2, 367	1. 6
Chemistry	6, 789	4. 7
Metallurgy	581	. 4
Meteorology	2, 123	1. 5
Other [1]	6, 587	4. 6
Mathematics [2]	5, 163	3. 6
Engineering	67, 500	46. 8
Civil	18, 304	12. 7
Mechanical	17, 250	12. 0
Electrical and electronic	14, 721	10. 2
Chemical	1, 195	. 8
Industrial	2, 175	1. 5
Other [3]	13, 855	9. 6
Biological sciences	7, 212	5. 0
Agricultural sciences (including forestry)	16, 454	11. 4
Health (selected categories) [4]	14, 640	10. 1
Social sciences (selected categories) [5]	5, 479	3. 8
Geography and cartography	2, 389	1. 7
Psychology	1, 815	1. 3
Operations research	427	. 3

[1] General physical sciences, astronomy and space science, technology, and other physical sciences.
[2] Actuary, mathematics, mathematical statistician, and statistics.
[3] General, materials, safety, fire prevention, maintenance, architecture, mining, petroleum production and natural gas, agricultural, and welding engineering.
[4] Medical officer, dental officer, and veterinarian.
[5] Social science, economics, history, and anthropological sciences.

Source: National Science Foundation, from U.S. Civil Service Commission data.

Persons classified as technicians numbered almost 93,400 in 1962. The more than 41,800 employees in engineering comprised more than two-fifths of all technicians. Engineering and mechanics technicians—two closely allied groups—accounted for 54,700 and over one-third of them were working in the electronics field. Almost 10,000 technicians were in the health fields, with more than 95 percent of them involved in clinical activities related to the medical and dental fields. There were about 2,700 in the biological sciences, and more than twice as many in the physical sciences. (See table III-23.)

TABLE III-23.—*Technicians employed in the Federal Government, by selected occupational group, October 1962*

Occupational group	Number	Percent
Total	93, 354	100. 0
Physical sciences	5, 946	6. 4
Mathematics	565	. 6
Engineering	41, 849	44. 8
Biological sciences	2, 710	2. 9
Agricultural sciences	10, 680	11. 4
Health (selected categories) [1]	9, 969	10. 7
Mechanics	12, 848	13. 8
Other [2]	8, 787	9. 4

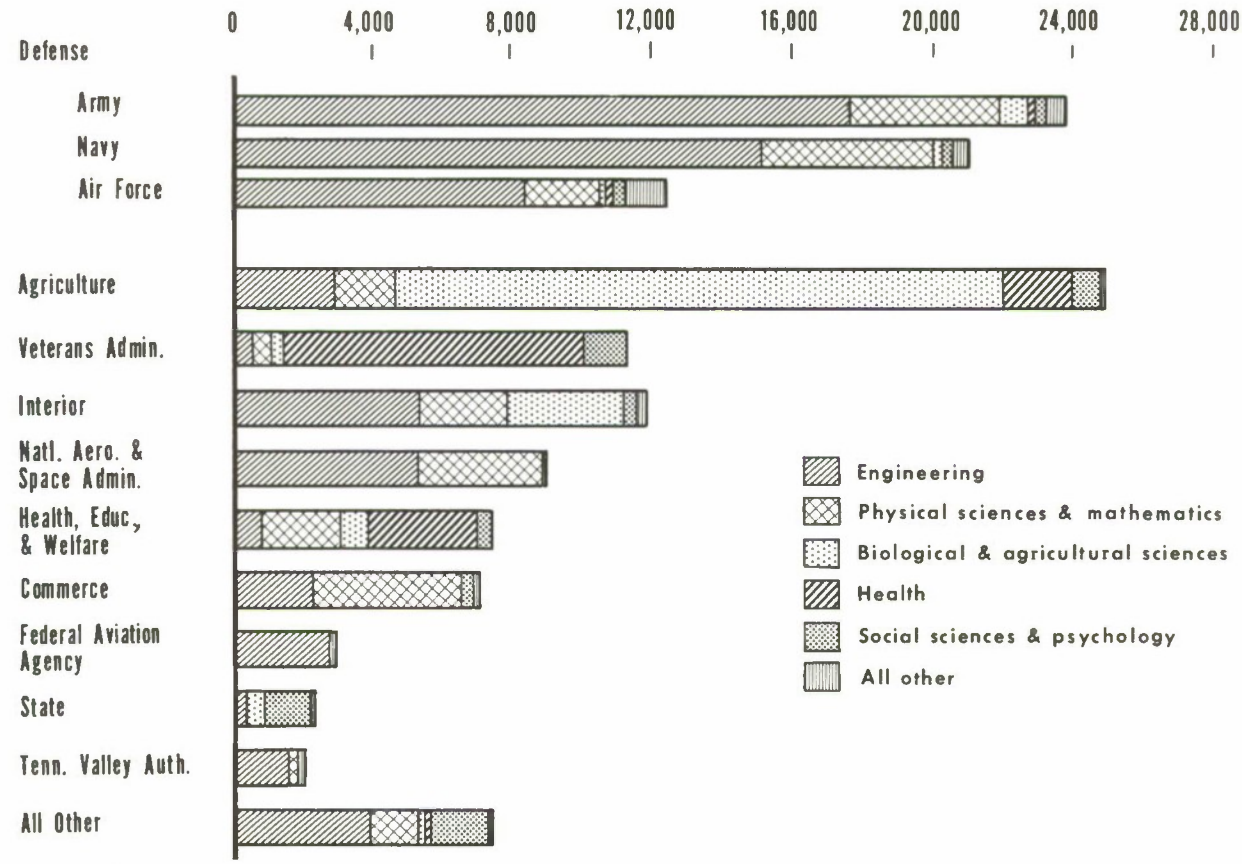
[1] Includes personnel classified as technicians, assistants, or aids in the health series (e.g., medical technician, physical therapy assistant).
[2] Social sciences, geography-cartography, and psychology.

Source: National Science Foundation, from U.S. Civil Service Commission data.

The Department of Defense as a whole employed the largest number of scientists, engineers, and technicians in 1962, with almost 57,500 scientists and engineers and 40,300 technicians. The Department of Agriculture, with more than 25,300 scientists and engineers, was the single agency employing the largest number of these personnel and was the second largest employer of technicians (almost 14,000). Over 88 percent of the agricultural scientists and 40 percent of those in the biological sciences were working for the Department of Agriculture. The Department of the Army was the second largest single employer of scientists and engineers (23,900) and was first in the employment of technicians (22,300), mostly engineering and mechanics technicians. (See tables III-24 and III-25.)

The Department of the Navy was the third largest employer of scientific and engineering personnel, but employed the largest number of mathematicians and physical scientists (primarily physicists). Over 11,000 scientists and engineers were employed by both the Department of the Interior and the Veterans Administration, with over three-fourths of these Veterans Administration personnel working in the health fields. The VA was the largest employer of health technicians, of whom about 6,800 of the total 10,000 worked in this agency. The National Aeronautics and Space Administration, a rapidly growing agency, employed nearly 9,000 scientists and engineers in 1962 (chart III-5).

Chart III–5. Scientists and engineers employed in the Federal Government, by agency and occupational group, October 1962



Sources: National Science Foundation and Civil Service Commission.

TABLE III–24.—*Scientists and engineers employed in the Federal Government, by agency and occupational group, October 1962*

Agencies	Total	Physical sciences	Mathematics [1]	Engineering	Biological sciences	Agricultural sciences (including forestry)	Health (selected categories) [2]	Social sciences (selected categories) [3]	Geography and cartography	Psychology	Operations research
Total	144,122	23,043	5,163	67,500	7,212	16,454	14,640	5,479	2,389	1,815	427
Department of Defense, total	57,452	8,716	2,574	41,470	887	146	462	408	1,874	545	370
Office of the Secretary of Defense	164	34	26	68	1	----	----	26	1	3	5
Department of the Army	23,940	3,335	914	17,726	670	109	271	179	463	180	93
Department of the Navy	20,925	3,844	1,020	15,201	134	14	71	20	321	183	117
Department of the Air Force	12,423	1,503	614	8,475	82	23	120	183	1,089	179	155
Department of Health, Education, and Welfare	7,573	1,891	366	877	874	18	3,096	275	----	176	----
Department of the Interior	11,896	2,567	51	5,467	2,067	1,159	3	336	245	----	1
Department of Agriculture	25,314	1,389	507	2,996	2,894	14,527	2,078	829	91	3	----
Department of Commerce	6,989	3,376	787	2,250	----	1	1	411	144	11	8
Department of Labor	1,059	----	157	38	----	----	----	863	----	1	----
Department of State	2,391	34	16	366	48	504	55	1,337	22	9	----
Federal Aviation Agency	2,875	15	33	2,708	27	----	38	9	5	21	19
Atomic Energy Commission	1,367	470	13	847	22	1	6	8	----	----	----
National Aeronautics and Space Administration	8,973	3,332	265	5,351	3	1	7	8	----	6	----
Tennessee Valley Authority	1,871	160	38	1,550	23	50	17	33	----	----	----
Veterans Administration	11,362	520	81	508	276	2	8,725	240	----	1,010	----
Other [4]	5,000	573	275	3,072	91	45	152	722	8	33	29

[1] Actuary, mathematics, mathematical statistician, and statistics.

[2] Medical officer, dental officer, and veterinarian.

[3] Social science, economics, history, and anthropological sciences.

[4] Includes the remaining agencies of the executive branch, except the Central Intelligence Agency and National Security Agency; also includes the small numbers of scientific and engineering personnel employed by agencies of the legislative and judicial branches.

Source: National Science Foundation, from U.S. Civil Service Commission data.

TABLE III-25.—*Technicians employed in the Federal Government, by agency and occupational group, October 1962*

Agencies	Total	Physical sciences	Mathematics	Engineering	Biological sciences	Agricultural sciences (including forestry)	Health (selected categories)[1]	Social sciences (selected categories)[2]	Geography and cartography	Psychology	Mechanics
Total	93,354	5,946	565	41,849	2,710	10,680	9,969	61	8,700	26	12,848
Department of Defense, total	40,309	1,433	297	21,603	323	136	1,818	3	3,902	10	10,784
Office of the Secretary of Defense	8										8
Department of the Army	20,280	435	77	10,498	279	79	1,239	2	3,466	1	4,204
Department of the Navy	12,636	539	167	7,997	36	19	92		297	4	3,485
Department of the Air Force	7,385	459	53	3,108	8	38	487	1	139	5	3,087
Department of Health, Education, and Welfare	2,578	292	1	135	841	2	1,219		2	3	83
Department of the Interior	9,300	591	12	3,844	518	1,551	4	4	2,570	1	205
Department of Agriculture	13,938	351	6	2,460	636	8,951	8	14	1,390		122
Department of Commerce	5,331	2,789	3	1,685			5	5	653	1	190
Department of Labor	17			1				16			
Department of State	235	1		54			64	14	37		65
Federal Aviation Agency	9,680	68	2	9,400	1		17		29	1	162
Atomic Energy Commission	81	24	1	35			1		7		13
National Aeronautics and Space Administration	1,613	72	239	1,210	7		2		1		82
Tennessee Valley Authority	727	73		547	3	13	18		68		5
Veterans Administration	7,383	87	1	85	374	23	6,767			10	36
Other[3]	2,162	165	3	790	7	4	46	5	41		1,101

[1] Includes personnel classified as technicians, assistants, or aids in the health series (e.g., medical technician, physical therapy assistants).

[2] Anthropology aid and economics assistant.

[3] Includes the remaining agencies of the executive branch, except the Central Intelligence Agency and National Security Agency; also includes the small numbers of scientific and engineering personnel employed by agencies of the legislative and judicial branches.

Source: National Science Foundation, from U.S. Civil Service Commission data.

Recent trends

Over the 4-year period from 1958 to 1962, the numbers of scientists and engineers employed by the Federal Government rose at an accelerating rate for an overall increase of 19 percent. Data have been arranged as nearly as possible in comparable occupational groups for the various years. However, attention should be directed to the overall trends rather than the exact numbers.

Overall, the number of scientists and engineers increased, on the average, nearly 5 percent a year during the 4-year period, although the percentage change between 1958 and 1959 was very small. In the 3 years from 1959 to 1962, an increase of more than 17 percent reflected, in large measure, the staffing of new agencies concerned with the Nation's security and space programs as well as an overall rise throughout the Government in the employment of scientists and engineers. (See table III-26.)

For the total 4-year period there were significant differences in trends between the major occupational groups as well as for individual occupations within these groups. Most engineering fields increased substantially; however, total employment in engineering appeared to decrease slightly between 1960 and 1961. This occurred through a reclassification of several thousand personnel in the National Aeronautics and Space Administration (NASA) from various engineering series (primarily mechanical and "other" engineering groups) to the "other" physical sciences group, which encompassed newer fields cutting across several scientific specializations. Many of these personnel were reclassified into engineering in 1962, accounting for much of the nearly 13-percent rise in engineering from 1961 to 1962.

In the physical sciences, employment grew by 46 percent from 1958 to 1962. The small decrease in the last year was due primarily to the previously noted reclassification in NASA, which affected the "other" group and resulted in a

TABLE III-26.—*Scientists and engineers employed in the Federal Government, by occupational group, 1958–62*

Occupational group	Number					Percent change				
	1958	1959	1960	1961	1962	1958–59	1959–60	1960–61	1961–62	1958–62
Total	121,088	122,859	127,970	134,333	144,122	1.5	4.2	5.0	7.3	19.0
Physical sciences	[1] 15,750	16,519	17,984	[2] 23,573	[2] 23,043	4.9	8.9	[2] 31.1	[2] −2.2	[2] 46.3
Physics	3,449	3,587	4,070	4,157	4,596	4.0	13.5	2.1	10.6	33.3
Geophysics, geology, and geodesy	1,854	1,972	2,067	2,167	2,367	6.4	4.8	4.8	9.2	27.7
Chemistry	5,606	5,730	5,845	6,211	6,789	2.2	2.0	6.3	9.3	21.1
Metallurgy	514	556	585	572	581	8.2	5.2	−2.2	1.6	13.0
Meteorology	1,921	1,918	1,986	2,032	2,123	−.2	3.5	2.3	4.5	10.5
Other [3]	2,406	2,756	3,431	[2] 8,434	[2] 6,587	14.5	24.5	[2] 145.8	[2] −21.9	[2] 173.8
Mathematics [4]	4,627	4,471	4,664	4,671	5,163	−3.4	4.3	.2	10.5	11.6
Engineering	[5] 57,122	57,808	60,978	[2] 59,974	[2] 67,500	1.2	5.5	[2] −1.6	[2] 12.5	[2] 18.2
Civil	15,719	16,344	16,910	17,666	18,304	4.0	3.5	4.5	3.6	16.4
Mechanical	13,325	13,439	14,191	12,790	17,250	.9	5.6	−9.9	34.9	29.5
Electrical and electronic	[5] 12,463	12,030	12,576	13,399	14,721	−3.5	4.5	6.5	9.9	18.1
Chemical	1,039	1,056	1,059	1,178	1,195	1.6	.3	11.2	1.4	15.0
Industrial	1,566	1,610	1,728	1,965	2,175	2.8	7.3	13.7	10.7	38.9
Other [6]	13,010	13,329	14,514	12,976	13,855	2.5	8.9	−10.6	6.8	6.5
Biological sciences	5,978	6,132	6,197	6,664	7,212	2.6	1.1	7.5	8.2	20.6
Agricultural sciences (including forestry)	15,220	15,314	15,439	15,838	16,454	.6	.8	2.6	3.9	8.1
Health (selected categories)[7]	13,056	13,402	13,728	14,282	14,640	2.7	2.4	4.0	2.5	12.1
Social sciences (selected categories)[8]	4,469	4,589	4,672	4,919	5,479	2.7	1.8	5.3	11.4	22.6
Geography and cartography	2,973	2,688	2,300	2,278	2,389	−9.6	−14.4	−1.0	4.9	−19.6
Psychology	1,697	1,672	1,689	1,788	1,815	−1.5	1.0	5.9	1.5	7.0
Operations research	196	264	319	346	427	34.7	20.8	8.5	23.4	117.9

[1] Excludes 1,878 personnel classified in "electronic research, development, and test" in 1958 as part of the physical sciences series, transferred here to "electronic engineering" to be consistent with the data for 1959 and 1960.

[2] Due to the reclassification of series that overlapped between some engineering series and "general physical science" in 1961, several thousand engineering personnel were transferred to the general physical science series. In 1962 many of these same personnel were transferred from "general physical science" back to engineering.

[3] Includes physical science administration (title changed to general physical science, February 1961), astronomy and space sciences, technology, and other physical sciences.

[4] Actuary, mathematics, mathematical statistician, and statistics.

[5] See footnote 1.

[6] General, materials, safety, fire prevention, maintenance, architectural, mining, petroleum production and natural gas, agricultural, and welding engineering.

[7] Medical officer, dental officer, and veterinarian; excludes related professional personnel such as nurses, public health administrator, dieticians, pharmacists, therapists, included in other NSF reports (see source below).

[8] Social science, economics, history, and anthropological sciences.

Sources: For 1958–60, National Science Foundation, *Scientific and Technical Personnel in the Federal Government, 1959 and 1960*; for 1961–62, National Science Foundation, from U.S. Civil Service Commission data.

drop of 22 percent although it was still more than 2½ times its 1958 size. The increased utilization of physicists in scientific projects resulted in a one-third rise in employment in this single occupation. With the exception of meteorology and metallurgy, each of which rose less than 15 percent, the remaining individual physical science occupations increased by more than 20 percent.

Employment in the biological sciences rose by almost 21 percent and in the agricultural sciences by 8 percent between 1958 and 1962, with the largest portion of the increase taking place in the last 2 years. The 12-percent increase in the health fields added 1,600 personnel, primarily medical practitioners. In the social sciences, most of the 1,000-personnel increase occurred during the latter 2 years of the 1958–62 period.

Geographic Distribution

The geographic distribution shows that fewer than 24,300, or 19 percent of the scientists and engineers employed by the Federal Government in October 1960, were working in the District of Columbia. Nearly 99,600 personnel—78 percent—were employed in the 50 States. Almost 3,400 were working in foreign countries. With the exception of the social scientists, 50 percent or more in every major group were employed outside the District of Columbia in the 50 States. (See table III-27.) In engineering, psychology, the biological sciences (including agricultural sciences), and the health fields, between 80 and 90 percent were in "other United States." Social sciences was the only field in which a substantial proportion—one-fifth—of the personnel were working in foreign countries.

TABLE III-27.—*Scientists and engineers in the Federal Government, by occupational group and geographic distribution, 1960*

Occupational group	Number of scientists and engineers	Percent				
		All areas	District of Columbia	Other United States [1]	Territories and possessions [2]	Foreign countries
Total	127, 970	100. 0	19. 0	77. 9	0. 5	2. 6
Physical sciences	17, 984	100. 0	30. 2	68. 2	. 4	1. 2
Mathematics [3]	4, 664	100. 0	43. 5	55. 7	(5)	. 8
Engineering	60, 978	100. 0	15. 9	81. 5	. 5	2. 1
Biological sciences [4]	21, 636	100. 0	9. 5	86. 7	. 7	3. 1
Health (selected categories) [6]	13, 728	100. 0	10. 1	87. 6	1. 2	1. 1
Social sciences (selected categories) [7]	4, 672	100. 0	50. 7	28. 8	. 4	20. 1
Geography and cartography	2, 300	100. 0	38. 8	56. 5	1. 8	2. 9
Psychology	1, 689	100. 0	17. 7	81. 8	. 4	. 1
Operations research	319	100. 0	29. 8	66. 8	----------	3. 4

[1] The 50 States.
[2] Canal Zone, Puerto Rico, Virgin Islands, and other possessions.
[3] Actuary, mathematics, mathematical statisticians, and statistics.
[4] Includes agricultural sciences.
[5] Less than 0.1 percent.
[6] Medical officer, dental officer, and veterinarian.
[7] Social science, economics, history, and anthropological sciences.

Source: National Science Foundation, from U.S. Civil Service Commission data.

Employment in State Governments

A 1962 survey of the employment of scientific and engineering personnel by State governments was carried out by the U.S. Department of Labor's Bureau of Labor Statistics. The survey results showed that about 48,000 scientists and engineers and 55,500 technicians were employed by State government agencies in January 1962.[7]

Patterns of Employment

Of the total scientific and engineering personnel employed in State governments, engineers accounted for about 34,000, more than twice the number of scientific personnel. Civil engineers comprised more than 88 percent of the engineering personnel. Of the scientists, three-fourths were life scientists. The biological and agricultural scientists each accounted for almost a third of the 14,000 State-employed scientists, and most of the remainder were employed as medical scientists and chemists. (See table III-28.)

[7] The survey excluded State-financed educational institutions, agricultural experiment stations, agricultural extension services, hospitals affiliated with State universities, and other agencies primarily concerned with judicial and legislative functions. Scientists and engineers employed in educational institutions have been covered in the U.S. Office of Education surveys conducted for the National Science Foundation.

TABLE III-28.—*Scientists and engineers employed by State governments, by occupation, January 1962*

Occupation	Number	Percent
Total	48, 029	100. 0
Engineers	33, 994	70. 8
Civil	30, 047	62. 6
Other engineers	3, 947	8. 2
Physical scientists	2, 727	5. 7
Chemists	1, 381	2. 9
Geologists and geophysicists	898	1. 9
Mathematicians [1]	448	. 9
Life scientists	10, 517	21. 9
Biological scientists	4, 514	9. 4
Agricultural scientists	4, 073	8. 5
Medical scientists	1, 930	4. 0
Psychologists	517	1. 1
Other scientists	274	. 6

[1] Includes statisticians and actuaries.

NOTE.—Percent detail may not add to total because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

TABLE III-29.—*Technicians employed by State governments, January 1962*

Technicians	Number	Percent
Total	55, 501	100. 0
Draftsmen	6, 684	12. 0
Surveyors	12, 240	22. 1
Engineering technicians	28, 343	51. 1
Physical science technicians	1, 030	1. 9
Medical, agricultural, and biological technicians	5, 671	10. 2
Other technicians	1, 533	2. 8

NOTE.—Percent detail may not add to total because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962,* Bull. No. 1412.

More than half of the 55,500 technicians employed in State agencies were classified as engineering technicians. (See table III-29.) Another third were working as draftsmen and surveyors, and the greater part of the remainder were in the medical, agricultural, and biological technician group.

About 97 percent of the scientists, engineers, and technicians were employed by the States in three main agency groupings—highways and public works, health and welfare, and agriculture and conservation. Highway and public works agencies employed nearly 91 percent of the engineers (primarily civil) and 84 percent of the technicians (almost three-fifths of them engineering technicians). In contrast, only 6 percent of the scientists were in highways and public works, compared with 53 percent who were in the agriculture and conservation agencies and almost 36 percent in health and welfare agencies (table III-30).

Within the scientists group, over 93 percent of the medical scientists and psychologists and about 40 percent of the biological scientists and chemists were employed in State health and welfare agencies. Almost all of the agricultural scientists and about 60 percent of the biological scientists were in agriculture and conservation agencies, as were slightly less than half of the geologists and geophysicists. About one-third of the mathematicians were in health and welfare agencies, and many others were working as actuaries in State insurance and retirement agencies (included in "other agencies"). (See table III-31.)

Recent Trends

Although data are available from only two State government surveys of scientific and technical personnel, the timespan between them covers 3 years, 1959–62. Thus, changes occurring from the first to the second survey are indicative of a recent trend. From January 1959 to January 1962 there was an increase from more than 40,700 to over 48,000, or about 18 percent, in the total number of scientists and engineers employed by the State governments; however, there were wide differences among the individual occupations (chart III-6).

Engineers, who are primarily employed in State highway agencies, increased almost twice as fast (21 percent) as scientists (12 percent) during this period. Within the engineering group, there was a 15-percent increase for civil engineers

TABLE III-30.—*Engineers, scientists, and technicians in State government agencies, by type of agency, January 1962*

Agency	Total		Engineers		Scientists		Technicians	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Total	103, 530	100. 0	33, 994	100. 0	14, 035	100. 0	55, 501	100. 0
Highway and public works	78, 199	75. 5	30, 775	90. 5	825	5. 9	46, 599	84. 0
Health and welfare	9, 638	9. 3	1, 257	3. 7	4, 986	35. 5	3, 395	6. 1
Agriculture and conservation	12, 292	11. 9	854	2. 5	7, 447	53. 9	3, 991	7. 2
Other agencies	3, 401	3. 3	1, 108	3. 3	777	5. 5	1, 516	2. 7

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962,* Bull. No. 1412.

TABLE III-31.—*Scientists employed in State governments, by occupation and type of agency, January 1962*

Occupation	All agencies	Highway and public works	Health and welfare	Agriculture and conservation	Other
Total	14,035	825	4,986	7,447	777
Physical scientists	2,727	706	783	838	400
Chemists	1,381	225	632	387	137
Geologists and geophysicists	898	382	----------	411	105
Mathematicians [1]	448	99	151	40	158
Life scientists	10,517	----------	3,662	6,594	261
Biological scientists	4,514	----------	1,760	2,636	118
Agricultural scientists	4,073	----------	79	3,922	72
Medical scientists	1,930	----------	1,823	36	71
Psychologists	517	----------	458	----------	59
Other scientists	274	119	83	15	57

[1] Includes statisticians and actuaries.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

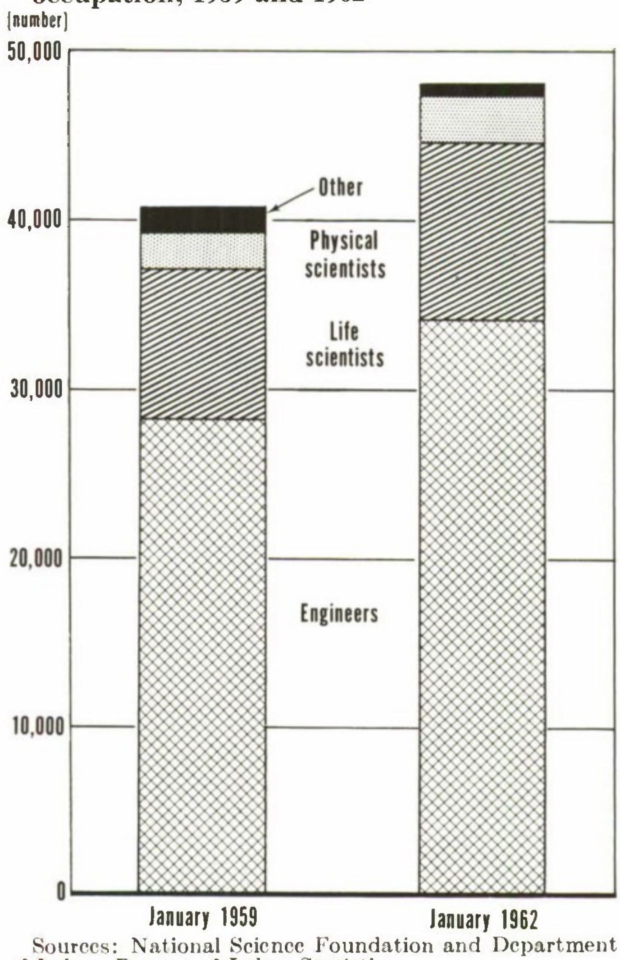
TABLE III-32.—*Scientists and engineers employed by State governments, by occupation, 1959 and 1962*

Occupation	January 1959	January 1962	Percent change
Total	40,730	48,029	17.9
Engineers	28,172	33,994	20.7
Civil	26,082	30,047	15.2
Other engineers	2,090	3,947	88.9
Physical scientists	2,140	2,727	27.4
Chemists	1,194	1,381	15.7
Geologists and geophysicists	603	898	48.9
Mathematicians [1]	343	448	30.6
Life scientists	8,846	10,517	18.9
Biological scientists	3,716	4,514	21.5
Agricultural scientists	3,473	4,073	17.3
Medical scientists	1,657	1,930	16.5
Psychologists [2]	1,282	517	−59.7
Other scientists	290	274	−5.5

[1] Includes statisticians and actuaries.
[2] Data for 1959 include an undetermined number of practitioners, specifically excluded from the 1962 survey. Direct comparison for the 2 years not valid.

Sources: National Science Foundation, *Employment of Scientific and Technical Personnel in State Government Agencies—Report on a 1959 Survey*, NSF 61-17; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

Chart III-6. Scientists and engineers employed in State government agencies, by occupation, 1959 and 1962



Sources: National Science Foundation and Department of Labor, Bureau of Labor Statistics.

and an 89-percent rise for the small number of other engineers. The trend among the scientist occupations ranged from an apparent 60-percent decline for psychologists (due to the exclusion of practitioners from the 1962 survey) to a 51-percent rise for geologists and geophysicists. Medical, agricultural, and biological scientists—three-fourths of the State government scientists in 1962—registered increases from almost 17 to 22 percent. (See table III–32.)

Technicians employed by State governments increased at about the same rate for the 1959–62 period as did the scientists and engineers. Engineering and physical science technicians accounted for almost two-thirds of the 8,700 increase in technicians over the 3-year period. Two of the technician occupation groups registered a decline: draftsmen, 6 percent, and medical, agricultural, and biological science technicians, 9 percent. (See table III–33.)

TABLE III–33.—*Technicians employed by State governments, by occupation, 1959 and 1962*

Occupation	January 1959	January 1962	Percent change
Total	46, 798	55, 501	18. 6
Draftsmen	7, 132	6, 684	−6. 3
Surveyors	9, 325	12, 240	31. 3
Engineering and physical science technicians	23, 781	29, 373	23. 5
Medical, agricultural and biological science technicians	6, 236	5, 671	−9. 1
Other	324	1, 533	373. 1

Sources: National Science Foundation, *Employment of Scientific and Technical Personnel in State Government Agencies—Report on a 1959 Survey*, NSF 61-17; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

Employment in Local Governments

Nationwide data on the employment of scientific and technical personnel by local governments are not available. In 1960, however, the Bureau of Labor Statistics undertook, at the request of the National Science Foundation, a pilot study of six States to determine the feasibility of collecting data on the employment of scientists, engineers, and technicians at the local government level. The six States (Connecticut, Pennsylvania, South Carolina, Wisconsin, Colorado, and Oregon) were selected to roughly represent different geographical areas. The governmental units covered included almost 1,000 counties, municipalities, townships, and special districts (school districts and other educational units or subunits were not included).

Although the pilot survey was not designed to produce national estimates for local governmental units, rough approximations of the total employment of scientists, engineers, and technicians were based on the data obtained for the six States. It was estimated that about 30,000 scientists and engineers and an equal number of technicians were employed in local governments in 1960.

Total employment in local governments appears to be the most important factor determining the employment of scientific and technical personnel. It was often found that some local governmental units, although large in terms of population covered, employed relatively few personnel because other governmental units provided most of the services for the area. About 75 percent of the scientists, almost 62 percent of the engineers, and 82 percent of the technicians in the six States surveyed were employed in the relatively small number of governmental units with more than 250 employees. In contrast, although units with fewer than 25 employees represented 80 percent of all those surveyed in the six States, they employed only 21 percent of the scientists, 16 percent of the engineers, and less than 5 percent of the technicians. In special districts, however, almost all of the scientists and over 60 percent of the engineers were employed in the smallest size governmental units. (See table III–34.)

Some indication of the type of work performed by scientific and technical personnel in local governments is available from information obtained from each local government agency in the 14 largest cities and 5 largest counties in the six States surveyed. About 78 percent of the engineers and 60 percent of the technicians in these large cities and counties were employed in public works agencies (including offices of city engineers, water boards, and planning commissions). By comparison, almost 78 percent of the scientists were in health and related agencies. (See table III–35.) These large units accounted for three-fifths of all the scientists, about two-fifths of the engineers, and two-thirds of all the technicians employed by all local governments in the six States.

TABLE III-34.—*Scientists, engineers, and technicians employed in local governments of six States,[1] by employment size and type of government unit, 1960*

Size of unit (total employment)	Total	Counties	Municipalities	Townships	Special districts
Scientists	661	140	362	8	151
	Percent distribution				
	100.0	100.0	100.0	100.0	100.0
1–24	21.2	1.4			91.4
25–99	2.3	4.3			6.0
100–249	1.3	5.0		25.0	
250 or more	75.2	89.3	100.0	75.0	2.6
Engineers	2,618	324	1,857	152	285
	Percent distribution				
	100.0	100.0	100.0	100.0	100.0
1–24	15.8	0.9	11.2	15.0	63.2
25–99	12.5	9.6	11.4	40.8	8.1
100–249	10.1	9.9	9.5	18.4	9.8
250 or more	61.5	79.6	67.9	25.7	18.9
Technicians	2,930	701	1,864	86	279
	Percent distribution				
	100.0	100.0	100.0	100.0	100.0
1–24	4.5		2.6		30.1
25–99	7.7	.4	7.8	9.3	25.1
100–249	5.9	3.6	6.1	27.9	2.9
250 or more	81.9	96.0	83.5	62.8	41.9

[1] Connecticut, Pennsylvania, South Carolina, Wisconsin, Colorado, and Oregon.

NOTE.—Detail may not add to totals because of rounding.

Source: "Pilot Survey of the Employment of Scientists, Engineers, and Technicians by Local Governments, January 1960" (unpublished), conducted by the U.S. Department of Labor, Bureau of Labor Statistics, for the National Science Foundation.

Employment in Nonprofit Organizations

Small but significant numbers of scientists and engineers are employed in nonacademic nonprofit organizations, particularly in research and development activities. Results of a 1958 survey of various types of nonprofit organizations (excludes colleges and universities) carried out by the Bureau of Labor Statistics for the National Science Foundation indicated employment of more than 7,100 engineers and scientists.[8] These organizations included private philanthropic foundations,

[8] On the basis of information obtained from the National Register of Scientific and Technical Personnel, it appears that more than 9,400 scientific personnel were employed in nonprofit organizations in 1962 (ch. IV, table IV-17).

TABLE III-35.—*Scientists, engineers, and technicians employed in selected large cities and counties in six States,[1] by type of agency, 1960*

Type of agency	Scientists	Engineers	Technicians
	Number		
Total	396	1,120	1,937
Public works	27	874	1,167
Health	308	50	305
Parks and recreation	43	87	114
Other agencies	18	109	351
	Percent		
Total	100.0	100.0	100.0
Public works	6.8	78.0	60.2
Health	77.8	4.5	15.7
Parks and recreation	10.9	7.8	5.9
Other agencies	4.5	9.7	18.1

[1] Connecticut, Pennsylvania, South Carolina, Wisconsin, Colorado, and Oregon.

Note.—Percent detail may not add to totals because of rounding.

Source: "Pilot Survey of the Employment of Scientists, Engineers, and Technicians by Local Governments, January 1960" (unpublished), conducted by the U.S. Department of Labor, Bureau of Labor Statistics, for the National Science Foundation.

voluntary health agencies, independent nonprofit research institutes, certain Federal contract research centers,[9] professional and technical societies, science museums, zoological and botanical gardens, and arboretums.

Patterns of Employment

About three-fifths of the more than 7,100 scientific and engineering personnel employed in these nonprofit organizations were working in independent research institutes, which are large performers of research and development. Well over 90 percent of these scientists and engineers were employed full time. (See table III-36.) In addition, these research institutes employed about 2,000 technicians, more than 90 percent of whom also worked full time.

[9] The centers managed by independent nonprofit organizations include: the RAND Corporation, Brookhaven National Laboratory, Oak Ridge Institute of Nuclear Studies, the National Radio Astronomy Observatory and (not included in the survey) the National Astronomical Observatory.

TABLE III-36.—*Scientists and engineers employed in nonprofit organizations, by type of organization, January 1958*

Type of organization	Number of scientists and engineers[1]		Percent distribution	
	Total	Full-time employed	Total	Full-time employed
Total	7,145	6,237	100.0	87.3
Private foundations	892	779	12.5	87.3
Voluntary health agencies	91	71	1.3	78.0
Independent research institutes	4,111	3,871	57.5	94.2
Federal contract research centers	1,051	683	14.7	65.0
Professional and technical societies	736	651	10.3	88.5
Science museums, zoological and botanical gardens, and arboretums	264	182	3.7	68.9

[1] Engineers, life and physical scientists, and social scientists.

Source: National Science Foundation, *Scientific Research and Development of Nonprofit Organizations—Expenditures and Manpower, 1957*, NSF 61-37.

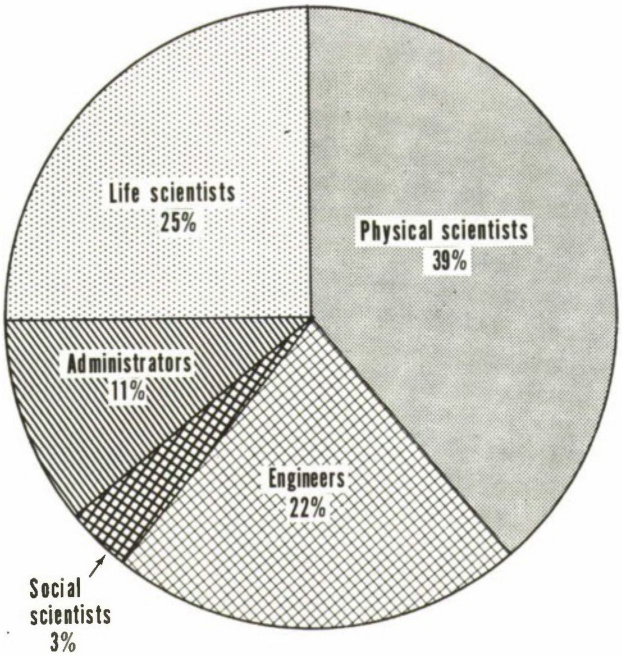
The second largest employer group, the Federal contract research centers, had slightly over 1,000 scientists and engineers on their staffs—one-third of whom were part-time personnel. The more than 350 technicians employed by the Federal centers all worked full time.

Voluntary health agencies employed the fewest scientists and engineers, only about 2 percent of their total employment. These agencies focus on the life sciences (particularly research on specific diseases) and are primarily sponsors rather than performers of research and development.

Physical scientists, the largest occupational group, accounted for about two-fifths of the 7,100 scientists and engineers employed in nonprofit organizations, compared with one-fourth for the life scientists. Engineers comprised more than one-fifth, followed by the much smaller group of administrators and social scientists. (See table III-37 and chart III-7.)

One-half of the life scientists and more than three-fifths of the engineers and physical scientists were employed in independent nonprofit research institutes in 1958. (See table III-38.) By contrast, more than four-fifths of the social scientists were employed in private foundations; none were reported in independent research institutes.

Chart III–7. Scientists and engineers employed in nonprofit organizations, by occupation, 1958



Source: National Science Foundation.

Employment in Research and Development

Well over four-fifths of the scientists and engineers employed in nonprofit organizations were engaged in R&D activities. Almost all scientists and engineers employed in independent research institutes and Federal contract research centers were involved in research and development, since these organizations are performers rather than sponsors of R&D projects. (See table III–39.) On the other hand, voluntary health agencies and professional and technical societies employ small proportions of their scientific personnel in research and development, reflecting the nature of their operations and activities.

TABLE III–37.—*Scientists and engineers employed in nonprofit organizations, by occupation, January 1958*

Occupation	Number [1]	Percent
Total	7, 145	100. 0
Engineers and natural scientists	6, 743	94. 4
Engineers	1, 563	21. 9
Physical scientists	2, 781	38. 9
Life scientists	1, 786	25. 0
Administrators	613	8. 6
Social scientists	402	5. 6
Social scientists [2]	247	3. 4
Administrators	155	2. 2

[1] Full-time and part-time staff.
[2] Includes psychologists.

Source: National Science Foundation, *Scientific Research and Development of Nonprofit Organizations—Expenditures and Manpower, 1957*, NSF 61-37.

TABLE III–38.—*Scientists and engineers employed in nonprofit organizations by occupation, and by type of organization, January 1958*

Occupation	All organizations	Private foundations	Voluntary health agencies	Independent research institutes	Federal contract research centers	Professional and technical societies	Science museums, zoological and botanical gardens, and arboretums
Total	[1] 7, 145	892	91	4, 111	1, 051	736	264
Engineers and natural scientists	6, 743	536	45	4, 111	1, 051	736	264
Engineers	1, 563	46	5	1, 196	231	84	1
Physical scientists	2, 781	112	5	1, 733	545	342	44
Life scientists	1, 786	271	18	893	253	155	196
Administrators	613	107	17	289	22	155	23
Social scientists [2]	402	356	46	----------	----------	----------	----------
Social scientists	247	231	16	----------	----------	----------	----------
Administrators	155	125	30	----------	----------	----------	----------

[1] Full-time and part-time staff.
[2] Includes psychologists.

Source: National Science Foundation, *Scientific Research and Development of Nonprofit Organizations—Expenditures and Manpower, 1957*, NSF 61-37.

TABLE III–39.—*Scientists and engineers engaged in research and development in nonprofit organizations, by type of organization, January 1958*

Type of organization	Scientists and engineers [1]	Number engaged in R&D [1]	Number engaged in R&D as percent of total
Total	7, 145	6, 150	86. 1
Private foundations	892	593	66. 5
Voluntary health agencies	91	24	26. 4
Independent research institutes	4, 111	4, 046	98. 4
Federal contract research centers	1, 051	1, 045	99. 4
Professional and technical societies	736	204	27. 7
Science museums, zoological and botanical gardens, and arboretums	264	238	90. 2

[1] Full-time and part-time staff.

Source: National Science Foundation, *Scientific Research and Development of Nonprofit Organizations—Expenditures and Manpower, 1957*, NSF 61–37.

Employment in the Atomic Energy Field

Information on the employment of scientific and engineering personnel in the atomic energy field is here presented separately since it is an area cutting across both private and government economic sectors. As defined here, the atomic energy field includes all activities directed toward the development and use of atomic energy.

Patterns of Employment

In January 1962, about 15,900 engineers, 10,000 scientists, and 17,900 technicians were employed by 274 primary atomic energy establishments, according to a survey conducted for the Atomic Energy Commission by the Bureau of Labor Statistics. Primary atomic energy establishments are defined as those with half or more of their personnel engaged in atomic energy activities. The survey [10] actually covered 488 establishments, which were estimated to employ about four-fifths of all workers in the atomic energy field, and included establishments which had contracts with the AEC as well as those which did not. Atomic energy employees not included were those working in uranium mining, non-AEC-owned facilities of educational institutions, or establishments engaged primarily in nuclear facilities construction. The data presented here on scientific and technical personnel concern only the 274 primary establishments.

Of the 10,000 scientists employed, more than two-thirds were physicists and chemists. In addition, a sizable number were health physicists, a unique occupation in the atomic energy field dealing with the safety of personnel who work with atomic materials. Mathematicians, metallurgists, and biological scientists comprised the bulk of the remaining scientist group in the atomic energy field.

Mechanical engineers and electrical and electronic engineers accounted for more than half the nearly 15,900 engineers employed in the prime atomic energy establishments surveyed. Chemical engineers and reactor engineers (specialists in nuclear reactor technology) together made up almost one-fourth, while smaller groups were employed as civil, metallurgical, and aeronautical engineers. More than 2,000 engineers could not be classified in any of the established specializations. (See table III–40.)

The 17,900 technicians who assisted engineers and scientists in the development and use of atomic energy were primarily classified as engineering and physical science technicians (over 10,000). Draftsman was the single largest occupation, with over 16 percent of the technicians. Technicians working in health physics and the medical, agricultural, and biological sciences together comprised about 10 percent of the technicians group. Overall there were about 69 technicians for every 100 engineers and scientists employed in the atomic energy field, although the ratio of technicians varied widely by the area of work.[11] This is the same as the overall industry ratio. (See table III–7.)

[10] Atomic Energy Commission, *Employment in the Atomic Energy Field: 1962 Occupational Survey.*

[11] The portion of the atomic energy field covered by the BLS–AEC survey was divided into 16 industrial segments classified on the basis of kind of atomic energy activity.

TABLE III–40.—*Scientists, engineers, and technicians employed in primary atomic energy establishments,*[1] *by occupation, January 1962*

Occupation	Number	Percent
Scientists	10, 011	100. 0
Agricultural scientists	10	. 1
Biological scientists	489	4. 9
Chemists	3, 375	33. 7
Geologists and geophysicists	42	. 4
Health physicists	456	4. 6
Mathematicians	1, 020	10. 2
Metallurgists	604	6. 0
Medical scientists	162	1. 6
Physicists	3, 389	33. 9
Other natural scientists	464	4. 6
Engineers	15, 881	100. 0
Aeronautical	118	. 7
Chemical	2, 295	14. 5
Civil (architectural, construction, structural, sanitary, etc.)	834	5. 3
Electrical and electronic	3, 568	22. 5
Mechanical	4, 920	31. 0
Metallurgical	799	5. 0
Reactor	1, 326	8. 3
Other engineers	2, 021	12. 7
Technicians	17, 920	100. 0
Draftsmen	2, 925	16. 3
Engineering and physical science	10, 948	61. 1
Electronics	2, 435	13. 6
Instrument	1, 339	7. 5
Other	7, 174	40. 0
Health physics	1, 117	6. 2
Medical, agricultural, and biological	621	3. 5
Radiographers	361	2. 0
Other technicians	1, 948	10. 9

[1] 274 establishments with half or more of their total personnel engaged in atomic energy activities.

Source: Atomic Energy Commission, *Employment in the Atomic Energy Field: 1962 Occupational Survey.*

Functions Performed by Scientific and Technical Personnel

Analysis of the functions performed by personnel in the atomic energy field revealed that over four-fifths of the scientists and three-fifths of the engineers and technicians were primarily engaged in research and development (including management and administration of research and development). About 27 percent of the engineers were in activities related to production and operations, compared with only 13 percent of the scientists but 35 percent of the technicians. Much smaller proportions were engaged in other activities such as technical sales and service and technical writing. (See table III–41.)

Of the entire engineering group, more than 60 percent in all fields except civil and "other engineers" not specifically classified were primarily engaged in research and development. Only among mechanical engineers, the largest group, were more than 1,000 personnel concerned with production and operations. (See table III–42.)

Very high proportions of personnel in almost all the scientist occupations were engaged in research and development. Over 90 percent of the physicists, metallurgists, and biological scientists; 83 percent of the mathematicians; and about 75 percent of the chemists were involved in research and development, dealing with such items as nuclear reactors, fuels, materials, and equipment. (See table III–43.)

Although almost three-fifths of the technicians were in research and development, about two-fifths of the large number of draftsmen were in production and operations activities, such as preparing detailed drawings of design layouts. About two-thirds of the 2,400 electronic technicians assisted scientists and engineers in research and development, while over one-fourth performed work related to the production processes. About three-fourths of the much smaller number of medical, agricultural, and biological technicians were assisting scientists in research work related to the effects of radiation on living organisms. (See table III–44.)

TABLE III-41.—*Percent distribution of employees in primary atomic energy establishments,*[1] *in selected occupational groups, by primary function, January 1962*

Occupational groups	All functions	Research and development[2]	Production and operations	Management and administration of other than R&D	Other
Scientists	100.0	82.8	12.6	2.3	2.3
Engineers	100.0	62.5	27.0	5.0	5.4
Technicians	100.0	59.1	34.8	.6	5.5
Other professional and administrative personnel	100.0	8.9	37.8	36.0	17.3
Skilled workers	100.0	3.9	83.0	.6	12.5

[1] 274 establishments with half or more of their total personnel engaged in atomic energy activities.

[2] Both performance of and management and administration of research and development.

NOTE.—Detail may not add to totals because of rounding.

Source: Atomic Energy Commission, *Employment in the Atomic Energy Field: 1962 Occupational Survey.*

TABLE III-42.—*Employment of engineers in primary atomic energy establishments,*[1] *by specialization and primary function, January 1962*

Engineering specialization	All functions	Research and development[2]	Production and operations	Management and administration of other than R&D	Other
	Number				
Total	15,881	9,927	4,292	797	865
Mechanical	4,920	3,205	1,327	246	142
Electrical and electronic	3,568	2,363	898	132	175
Chemical	2,295	1,418	707	109	61
Reactor	1,326	1,173	106	28	19
Metallurgical	799	618	117	40	24
Civil	834	248	307	110	169
Aeronautical	118	112	2	2	2
Other engineering	2,021	790	828	130	273
	Percent				
Total	100.0	62.5	27.0	5.4	5.4
Mechanical	100.0	65.1	27.0	5.0	2.9
Electrical and electronic	100.0	66.2	25.2	3.7	4.9
Chemical	100.0	61.8	30.8	4.7	2.7
Reactor	100.0	88.4	8.0	2.1	1.4
Metallurgical	100.0	77.3	14.6	5.0	3.0
Civil	100.0	29.7	36.8	13.2	20.3
Aeronautical	100.0	94.9	1.7	1.7	1.7
Other engineering	100.0	39.1	41.0	6.4	13.5

[1] 274 establishments with half or more of their total personnel engaged in atomic energy activities.

[2] Both performance of and management and administration of research and development.

NOTE.—Percent details may not add to totals because of rounding.

Source: Atomic Energy Commission, *Employment in the Atomic Energy Field: 1962 Occupational Survey.*

TABLE III-43.—*Employment of scientists in primary atomic energy establishments,*[1] *by field and primary function, January 1962*

Scientific field	All functions	Research and development[2]	Production and operations	Management and administration of other than R&D	Other
	Number				
Total	10, 011	8, 292	1, 258	231	230
Physics	3, 389	3, 093	223	31	42
Chemistry	3, 375	2, 526	715	102	32
Mathematics	1, 020	844	79	34	63
Metallurgy	604	526	24	8	10
Biological sciences	489	459	22	1	7
Health physics	456	265	139	31	21
Medical sciences	162	122	20	11	9
Geology and geophysics	42	10	22	8	2
Agricultural sciences	10	5	4	1	----------
Other natural sciences	464	406	10	4	44
	Percent				
Total	100. 0	82. 8	12. 6	2. 3	2. 3
Physics	100. 0	91. 3	6. 6	. 9	1. 2
Chemistry	100. 0	74. 8	21. 2	3. 0	. 9
Mathematics	100. 0	82. 7	7. 7	3. 3	6. 2
Metallurgy	100. 0	93. 0	4. 0	1. 3	1. 7
Biological sciences	100. 0	93. 9	4. 5	. 2	1. 4
Health physics	100. 0	58. 1	30. 5	6. 8	4. 6
Medical sciences	100. 0	75. 3	12. 3	6. 8	5. 6
Geology and geophysics	100. 0	23. 8	52. 4	19. 0	4. 8
Agricultural sciences	100. 0	50. 0	40. 0	10. 0	----------
Other natural sciences	100. 0	87. 5	2. 2	. 9	9. 5

[1] 274 establishments with half or more or their total personnel engaged in atomic energy activities.
[2] Both performance of and management and administration of research and development.

NOTE.—Percent detail may not add to totals because of rounding.

Source: Atomic Energy Commission, *Employment in the Atomic Energy Field: 1962 Occupational Survey.*

Scientists and Engineers in the Military Services

Estimates of the number of scientists and engineers who are actually performing professional scientific and technical work in the various military services (Army, Navy, and Air Force) are generally unavailable. The utilization of personnel with scientific and technical training varies considerably in the services, depending upon the policies and programs of the individual service. Overall, it is estimated that roughly 20,000 military engineers and scientists were engaged in a wide variety of professional, scientific, and technical duties in 1960. The greatest number of such personnel were in the Air Force, with far fewer numbers in the Navy and Army.

Utilization of Scientists and Engineers

In addition to basic information on the numbers of scientific and technical personnel and where they are employed, knowledge of how such personnel are being utilized is important to the meaningful assessment of the country's personnel needs and resources. One aspect of utilization on

TABLE III–44.—*Employment of technicians in primary atomic energy establishments,*[1] *by occupation and primary function, January 1962*

Technician occupation	All functions	Research and development [2]	Production and operations	Management and administration of other than R&D	Other
	Number				
Total	17, 920	10, 598	6, 238	102	982
Draftsman	2, 925	1, 490	1, 244	13	178
Engineering and physical science	10, 948	7, 845	2, 665	34	404
Electronic	2, 435	1, 598	640	15	182
Instrument	1, 339	914	357	14	54
Other	7, 174	5, 333	1, 668	5	168
Health physics	1, 117	152	768	23	174
Medical, agricultural, and biological	621	455	71	9	86
Radiographer	361	41	297	11	12
Other technicians	1, 948	615	1, 193	12	128
	Percent				
Total	100. 0	59. 1	34. 8	0. 6	5. 5
Draftsman	100. 0	50. 9	42. 5	. 4	6. 1
Engineering and physical science	100. 0	71. 7	24. 3	. 3	3. 7
Electronic	100. 0	65. 6	26. 3	. 6	7. 5
Instrument	100. 0	68. 3	26. 7	1. 0	4. 0
Other	100. 0	74. 3	23. 3	. 1	2. 3
Health physics	100. 0	13. 6	68. 8	2. 1	15. 6
Medical, agricultural and biological	100. 0	73. 3	11. 4	1. 4	13. 8
Radiographer	100. 0	11. 4	82. 3	3. 0	3. 3
Other technicians	100. 0	31. 6	61. 2	. 6	6. 6

[1] 274 establishments with half or more of their total personnel engaged in atomic energy activities.

[2] Both performance of and management and administration of research and development.

NOTE.—Percent detail may not add to totals because of rounding.

Source: Atomic Energy Commission, *Employment in the Atomic Energy Field: 1962 Occupational Survey.*

which data have become available in recent years is the functions performed by scientific and technical personnel in various sectors of the economy; that is, what duties and kinds of work scientific and technical personnel perform, how many conduct research and development as opposed to teaching, how many perform some research work in addition to other work activities, etc.

Estimates made by the National Science Foundation indicate that in 1960 more than one-third of the scientists and engineers together were primarily engaged in production and operations, and another third were in research and development. However, the highest proportion of scientists was shown in R&D activities, and an equally high proportion of engineers was involved in production and operations. (See table III–45.)

The distribution of scientists and engineers by function varies considerably among the broad economic sectors of employment. Although almost equal numbers of industrial scientists and engineers were in production and operations and

TABLE III–45.—*Percent distribution of scientists and engineers employed in all sectors of the economy, by primary function, 1960*[1]

Function	Scientists and engineers	Scientists	Engineers
Total	100	100	100
Production and operations	35	24	41
Research and development[2]	34	42	30
Management and administration	7	4	8
Other[3]	24	30	21

[1] Excludes scientists and engineers in the Armed Forces.
[2] Includes management and administration of research and development.
[3] Includes teaching.
Source: National Science Foundation estimates.

in R&D work, more than half of all scientists and engineers employed in government (Federal, State, and local) were primarily engaged in activities related to production and operations. The biggest proportion of scientists and engineers in educational institutions and other nonprofit organizations was concerned with teaching, although nearly two-fifths were conducting research. (See table III–46.) As indicated previously, earlier survey data showed that personnel employed in nonprofit organizations were primarily concerned with the performance or administration of R&D programs.

Functions of Scientific and Engineering Personnel in Industry

Information on how industry employs scientific and engineering personnel in different functions has become available only in recent years. The 1962 and 1961 surveys of industry obtained data on the main work activities of such personnel in six broad categories: research and development, management and administration of research and development, management and administration of all other activities, technical sales and service, production and operations, and all other activities. The earlier industry surveys obtained data on the same categories, except that "exploration" was listed as a separate category and "technical sales and service" was included in "all other activities." Since many personnel perform more than one function in their jobs, employers were requested to classify scientists and engineers in the one functional category occupying the largest proportion of their time (i.e., defined as "primarily engaged in").

Patterns in Industry. In 1962, more than 34 percent of the 851,600 scientists and engineers in industry were primarily engaged in production and operations—the leading activity of industrial scientists and engineers. Another 30 percent were performing research and development, and somewhat less than 6 percent were managing and administering R&D activities. Management and administration of activities other than research and development accounted for nearly 13 percent of the scientists and engineers, while the remaining 17 percent were involved in technical sales and service and "all other activities" (e.g., exploration, purchasing, technical writing, operations research, etc.). (See table III–47.)

Although sizable numbers of scientific and engineering personnel in almost every occupation were mainly concerned with production and operations, engineers (252,900), metallurgists (4,600), and geologists and geophysicists (4,900) were the only occupational groups with more than one-third of their personnel in this function. More physicists, mathematicians, biological scien-

TABLE III–46.—*Percent distribution of scientists and engineers, by economic sector and by primary function, 1960*[1]

Sector	All functions	Production and operations	Research and development[2]	Management and administration	Other[3]
Total	100	35	34	7	24
Industry	100	37	35	8	20
Government	100	55	26	6	13
Education[4]	100	----------	38	----------	[5] 62

[1] Excludes scientists and engineers in the Armed Forces.
[2] Includes management and administration of research and development.
[3] Includes teaching.
[4] Includes nonprofit organizations.
[5] All functions except research and development.
Source: National Science Foundation estimates.

TABLE III-47.—*Scientists and engineers employed in industry, by primary function, 1962*

Functions	Number	Percent
Total	851, 600	100. 0
Research and development	256, 600	30. 1
Management and administration of—		
Research and development	47, 200	5. 5
Other activities	107, 500	12. 6
Technical sales and service	92, 700	10. 9
Production and operations	291, 900	34. 3
Other functions	55, 700	6. 5

NOTE: Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

tists, chemists, and unclassified scientists were engaged in R&D work (exclusive of management and administration) than in any other function. The 13,900 physicists in particular were concentrated in research and development: more than 8 out of 10 were involved in conducting or managing and administering programs in this area (table III-48 and chart III-8). The only occupational group with a large proportion of personnel in technical sales and service were the medical scientists—about two-fifths of the 7,700 employed were so engaged. Although only about 7 percent of the scientists and engineers were reported in "other functions," one-third of the 12,900 geologists and geophysicists were in this group because of the inclusion of exploration activities in this category.

A comparison of the functions performed by scientists and engineers in 1961 with those of 1962 reveals virtually no overall change in the proportions in each activity, except for the slight decline of more than 1 percentage point in research and development, and a corresponding rise in production and operations. (See table III-49.) Among the individual occupations, engineers and chemists—numerically the two largest occupations—showed similar changes, but more striking shifts were shown among several of the others. (See table III-50.) For example, biological scientists engaged in R&D work and in production and operations both increased about 6 percentage points. Medical scientists showed a somewhat

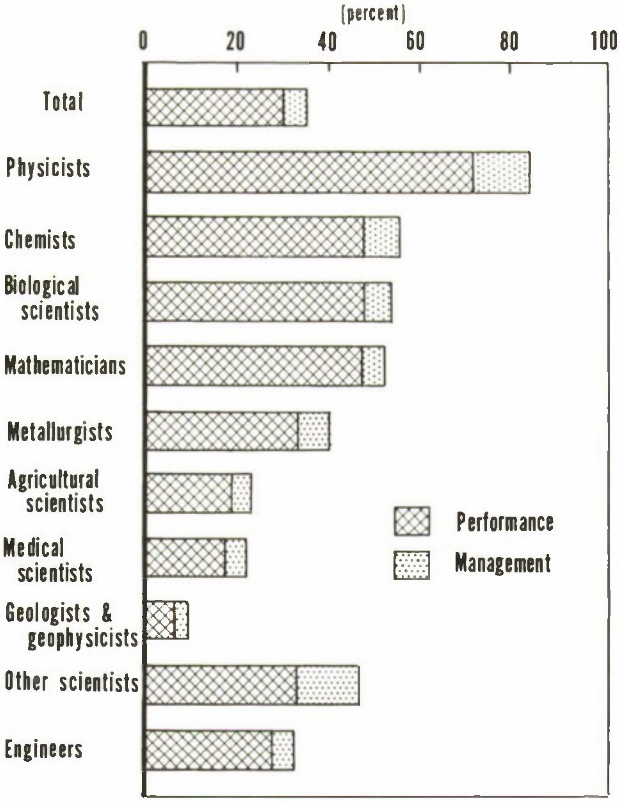
TABLE III-48.—*Scientists and engineers employed in industry, by occupation and primary function, 1962*

Occupation	Scientists and engineers, all functions	Research and development	Management and administration of—		Technical sales and service	Production and operations	Other functions
			Research and development	Other than R&D			
Total	851, 600	256, 600	47, 200	107, 500	92, 700	291, 900	55, 700
Engineers	684, 600	186, 200	34, 800	92, 800	74, 900	252, 900	43, 100
Physical scientists	135, 500	60, 900	10, 400	11, 300	10, 900	33, 400	8, 700
Chemists	81, 600	38, 700	6, 800	5, 800	7, 800	20, 100	2, 500
Physicists	13, 900	10, 000	1, 800	400	400	1, 000	300
Metallurgists	12, 400	4, 200	800	1, 700	800	4, 600	300
Geologists and geophysicists	12, 900	900	300	2, 100	400	4, 900	4, 300
Mathematicians	14, 700	7, 100	700	1, 300	1, 500	2, 800	1, 300
Life scientists	26, 500	7, 900	1, 400	2, 900	6, 400	5, 100	2, 800
Medical scientists	7, 700	1, 400	400	700	3, 400	600	1, 200
Agricultural scientists	8, 600	1, 600	500	1, 700	1, 100	2, 300	1, 300
Biological scientists	10, 200	4, 900	600	500	1, 900	2, 100	200
Other scientists (unclassified)	5, 000	1, 700	700	500	500	600	1, 100

NOTE.—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Chart III-8. R&D scientists and engineers as percent of all scientists and engineers in industry, by occupation, 1962



Source: Department of Labor, Bureau of Labor Statistics.

TABLE III-49.—*Percent distribution of scientists and engineers employed in industry, by primary function, 1961 and 1962*

Functions	January 1961	January 1962
Total	100. 0	100. 0
Research and development	31. 5	30. 1
Management and administration of—		
Research and development	5. 4	5. 5
Other activities	12. 2	12. 6
Technical sales and service	11. 1	10. 9
Production and operations	32. 9	34. 3
Other functions	6. 9	6. 5

NOTE.—Detail may not add to totals because of rounding.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

smaller decline in R&D activities and in technical sales and service and a large proportionate increase in "other functions." The proportion of scientists in the "unclassified" group who were concerned with performing research and development in 1961 declined sharply by 1962 with a corresponding increase in every other function reported.

Overall, there was a movement toward greater concentration of scientists and engineers concerned with production and operations in the 1-year period ending in January 1962. Although those scientific and engineering personnel conducting R&D decreased slightly, there was a substantial increase in personnel managing and administering R&D programs as well as scientists and engineers responsible for the management and administration of other activities. (See table III-51.)

The proportions of scientists and engineers in different functions in 1962 vary considerably by industry. In only three of the industry groups in manufacturing—lumber and wood products, paper, and primary metals—were about half or more of the scientists and engineers employed in production and operations, compared with many more in nonmanufacturing industries. Transportation equipment, electrical equipment, and ordnance and accessories—industries employing nearly a third of all scientists and engineers—utilized almost half of their personnel in the performance of research and development. Among nonmanufacturing industries, only the service industries had more than one-fourth in this function. However, only the food and the engineering and scientific instruments industries had more than 10 percent of their scientific and engineering personnel in the management and administration of R&D activities. Wholesale and retail trade was the only industry which had over half of its scientists and engineers in technical sales and service. (See table III-52.)

Among the engineers in industry (684,800), nearly two-fifths were primarily engaged in production and operations, and more than one-fourth were in research and development. However, in the 2 individual industries employing the largest numbers of engineers, more than half the personnel were primarily engaged in research and development—26,300 of the 50,500 engineers employed by the communication equipment industry and 38,300 of the 74,400 in aircraft and parts. Both of these

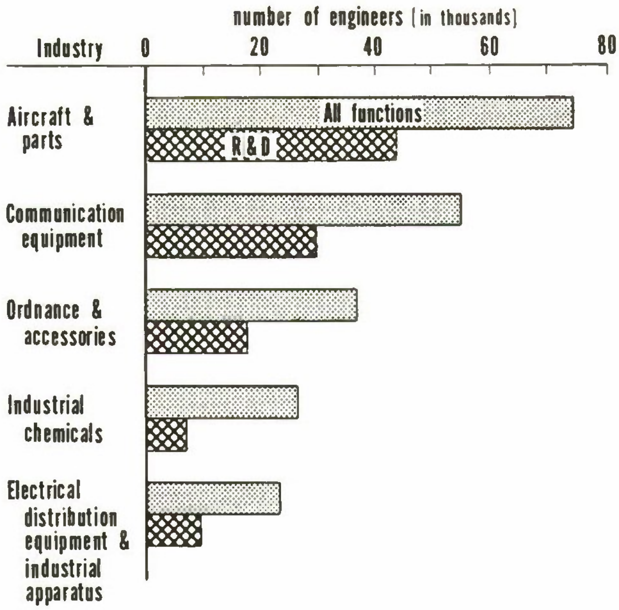
TABLE III-50.—*Percent distribution of scientists and engineers employed in industry, by occupation and primary function, 1961 and 1962*

Occupation	Scientists and engineers, all functions	Research and development	Management and administration of—		Technical sales and service	Production and operations	Other functions
			Research and development	Other than R&D			
	January 1962						
Total	100.0	30.1	5.5	12.6	10.9	34.3	6.5
Engineers	100.0	27.2	5.1	13.6	10.9	36.9	6.3
Physical scientists	100.0	44.9	7.6	8.4	8.0	24.6	6.5
Chemists	100.0	47.4	8.3	7.1	9.5	24.6	3.0
Physicists	100.0	72.1	12.6	2.8	3.0	7.0	2.4
Metallurgists	100.0	33.7	6.8	13.7	6.3	37.3	2.3
Geologists and geophysicists	100.0	6.8	2.3	16.3	2.8	38.1	33.6
Mathematicians	100.0	48.4	4.6	8.8	10.3	19.0	9.0
Life scientists	100.0	29.7	5.4	10.9	24.3	19.1	10.5
Medical scientists	100.0	17.8	5.0	9.0	44.2	7.8	16.1
Agricultural scientists	100.0	18.7	5.3	20.0	13.3	27.3	15.4
Biological scientists	100.0	48.0	5.9	4.7	18.5	20.7	2.2
Other scientists (unclassified)	100.0	33.4	13.6	10.6	9.3	12.1	21.0
	January 1961						
Total	100.0	31.5	5.4	12.2	11.1	32.9	6.9
Engineers	100.0	28.7	4.9	13.2	11.3	35.3	6.6
Physical scientists	100.0	45.6	8.4	8.2	5.8	26.1	6.0
Chemists	100.0	48.7	9.3	7.1	6.6	25.4	2.8
Physicists	100.0	72.9	11.2	2.5	3.1	7.9	2.4
Metallurgists	100.0	33.8	5.6	12.5	7.3	38.2	2.7
Geologists and geophysicists	100.0	5.4	1.4	17.9	1.7	38.7	34.9
Mathematicians	100.0	46.3	4.5	10.7	11.0	15.8	11.8
Life scientists	100.0	28.0	4.9	8.1	30.1	16.1	12.9
Medical scientists	100.0	19.8	6.8	10.5	46.6	10.6	2.6
Agricultural scientists	100.0	15.2	2.5	12.6	24.6	24.2	20.9
Biological scientists	100.0	41.7	4.9	3.5	19.8	15.0	15.1
Other scientists (unclassified)	100.0	46.7	10.9	7.9	7.9	10.2	16.3

NOTE.—Detail may not add to totals because of rounding.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Chart III–9. R&D engineers compared with all engineers in five selected manufacturing industries, 1962



Source: Department of Labor, Bureau of Labor Statistics.

industries are involved in extensive R&D work related to the Nation's defense and space programs. Engineers who were concerned with production and operation made up two-fifths or more of the engineering total in most of the other manufacturing industries and in all of the nonmanufacturing industries except wholesale and retail trade; finance, insurance, and real estate; and commercial laboratories. (See table III–53 and chart III–9.)

Industrial Scientists and Engineers in Research and Development. Data from the 1962 survey of industry show that engineers and chemists together accounted for nearly 88 percent of the almost 304,000 scientists and engineers primarily performing or managing and administering R&D activities. This does not mean that other scientific personnel were not important to industrial research and development in terms of their contributions or numbers. The next largest category, physicists, contained almost 12,000 R&D personnel. Other groups ranged from almost

TABLE III–51.—*Scientists and engineers employed in industry, by primary function, 1961 and 1962*

Function	Number		Percent change
	January 1961 [1]	January 1962	
Total	814, 800	851, 600	4. 5
Research and development	257, 000	256, 600	—. 2
Management and administration of—			
Research and development	44, 000	47, 200	7. 3
Other activities	99, 400	107, 500	8. 1
Technical sales and service	90, 300	92, 700	2. 7
Production and operations	268, 200	291, 900	8. 8
Other functions	55, 900	55, 700	—. 4

[1] Total for 1961 is based on the 1961 industry survey and differs from the adjusted total as derived from the 1962 survey. Data on adjusted functions not collected in 1962 survey.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63–32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

8,000 for mathematicians to 1,200 for geologists and geophysicists.

The proportions of scientific and engineering personnel in research and development varied considerably among the different occupations, ranging from about 9 percent for geologists and geophysicists to 85 percent for physicists. (See table III–54.) In four of the scientific occupations—physicists, chemists, biological scientists, and mathematicians—more than half of the personnel were primarily concerned with R&D programs.

Technicians in research and development were widely distributed throughout industry in 1962. Their employment as aids to R&D scientists and engineers was most concentrated in two major industry groups—transportation equipment and electrical equipment and supplies—which contained more than 59,000 R&D technicians or nearly 40 percent of the total. (See table III–55.) Among the individual industries, those with large proportions of their technicians engaged in R&D (over 40 percent) included aircraft and parts, motor vehicles, drugs, communication equipment, plastics and synthetics, and office, computing, and accounting machines.

TABLE III–52.—*Percent distribution of scientists and engineers, by industry and primary function, 1962*

Industry	Scientists and engineers, all functions	Research and development	Management and administration of— Research and development	Management and administration of— Other than R&D	Technical sales and service	Production and operations	Other functions
Total	100.0	30.1	5.5	12.6	10.9	34.3	6.5
Manufacturing	100.0	36.6	6.7	10.9	9.7	30.9	5.2
Ordnance and accessories	100.0	45.7	4.4	3.0	3.6	41.6	1.7
Food and kindred products	100.0	24.9	11.1	18.6	2.0	36.0	7.5
Textile mill products	100.0	41.5	9.8	10.8	3.0	34.0	1.0
Lumber and wood products, except furniture	100.0	8.9	7.1	22.4	(1)	57.5	3.6
Paper and allied products	100.0	17.6	5.6	17.3	6.2	49.4	4.0
Chemicals and allied products	100.0	36.2	5.3	8.3	11.4	30.5	8.3
Industrial chemicals	100.0	34.2	3.6	6.5	6.0	39.4	10.3
Plastics and synthetics, except glass	100.0	36.8	7.7	12.1	11.3	28.5	3.7
Drugs	100.0	33.9	5.8	8.2	26.1	17.1	8.9
Agricultural chemicals	100.0	29.6	2.4	22.6	5.1	36.9	3.4
Other chemical products	100.0	44.9	8.5	9.6	8.1	24.1	4.8
Petroleum refining	100.0	16.5	2.2	14.2	6.4	41.8	18.8
Rubber and miscellaneous plastics products	100.0	27.3	9.6	14.0	9.7	34.6	4.9
Stone, clay, and glass products	100.0	23.9	8.7	16.5	11.7	35.5	3.7
Primary metal industries	100.0	16.2	3.3	18.9	8.3	48.6	4.6
Blast furnaces and basic steel products	100.0	16.0	3.1	19.0	7.9	48.1	5.9
Other primary metal industries	100.0	16.7	3.6	18.8	9.0	49.5	2.4
Fabricated metal products	100.0	18.1	6.7	18.5	17.0	35.2	4.5
Machinery, except electrical	100.0	30.8	7.5	13.4	16.0	27.3	4.9
Engines and turbines	100.0	32.9	6.8	14.1	13.6	30.0	2.6
Office, computing, and accounting machines	100.0	54.2	9.5	5.1	6.3	19.9	4.9
Farm machinery and equipment	100.0	32.5	7.7	16.9	9.6	28.3	4.9
Other machinery	100.0	22.6	6.9	15.5	20.6	29.3	5.2
Electrical equipment and supplies	100.0	45.5	7.1	9.2	12.5	21.3	4.5
Electric distribution equipment and industrial apparatus	100.0	35.3	7.2	11.4	19.1	23.6	3.4
Household appliances	100.0	38.8	9.8	11.5	1.8	35.0	3.1
Communication equipment	100.0	52.7	7.0	8.1	6.9	18.9	6.4
Electric lighting and wiring equipment	100.0	30.8	7.8	14.5	13.8	28.9	4.1
Electronic components and accessories	100.0	35.7	6.1	10.2	19.8	26.6	1.6
Radio and television receiving sets	100.0	63.4	8.3	3.9	12.2	9.3	2.8
Miscellaneous electrical equipment and supplies	100.0	33.6	5.4	11.2	20.1	25.5	4.3
Transportation equipment	100.0	47.3	7.3	9.1	5.0	28.6	2.7
Motor vehicles and equipment	100.0	33.6	6.5	15.9	5.7	36.0	2.3
Aircraft and parts	100.0	52.5	7.7	6.7	4.7	25.9	2.5
Other transportation equipment	100.0	21.3	5.7	17.2	6.3	41.3	8.2
Instruments and related products	100.0	40.0	9.8	8.1	11.2	26.6	4.4
Engineering and scientific instruments	100.0	45.1	12.1	8.9	6.4	24.3	3.3
Other instruments and related products	100.0	36.8	8.4	7.6	14.1	28.0	5.0
Other manufacturing industries	100.0	28.2	8.2	13.9	5.1	38.5	6.1
Nonmanufacturing	100.0	13.4	2.6	17.1	13.9	43.0	10.0
Mining	100.0	6.6	2.6	22.9	4.8	52.5	10.6
Metal mining	100.0	6.9	2.6	28.9	2.6	52.1	6.9
Coal mining	100.0	5.3	(1)	10.7	5.7	73.4	4.1
Crude petroleum and natural gas	100.0	6.0	2.8	24.0	4.4	49.6	13.2
Quarrying and nonmetallic mining	100.0	14.0	4.5	22.6	10.5	43.8	4.6
Contract construction	100.0	.8	.7	21.4	7.4	53.0	16.7
Transportation and public utilities	100.0	3.8	1.0	22.1	5.2	59.1	8.7
Railroad transportation	100.0	1.9	(1)	17.9	2.1	55.6	21.6
Communication	100.0	2.2	.7	21.5	2.4	72.5	.7
Electric, gas, and sanitary services	100.0	4.5	1.2	22.8	8.1	52.2	11.3
Other transportation	100.0	7.1	1.2	25.4	(1)	62.4	3.5
Wholesale and retail trade	100.0	7.8	1.0	15.6	57.7	15.4	2.5
Finance, insurance, and real estate	100.0	3.7	5.0	24.4	11.8	31.1	23.9
Services	100.0	29.3	4.8	10.3	8.8	37.2	9.5
Commercial laboratories; business and management consulting services	100.0	51.7	7.5	9.6	7.1	18.3	5.8
Medical and dental laboratories	100.0	12.2	(1)	8.5	17.4	59.8	(1)
Engineering and architectural services	100.0	15.3	3.2	11.2	8.9	49.2	12.1
Other services	100.0	(1)	(1)	(1)	34.5	53.5	9.6
Agriculture, forestry, and fisheries	100.0	(1)	(1)	50.2	26.4	18.8	(1)

[1] Percentages not computed; less than 50 cases.

NOTE.—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

TABLE III–53.—*Engineers, by industry and primary function, 1962*

Industry	Engineers, all functions	Research and development	Management and administration of— Research and development	Management and administration of— Other than R&D	Technical sales and service	Production and operations	Other functions
Total	684,800	186,200	34,800	92,800	74,900	252,900	43,100
Manufacturing	480,300	163,800	30,000	56,300	47,400	159,900	22,800
Ordnance and accessories	36,900	16,100	1,500	1,100	1,400	16,200	600
Food and kindred products	10,400	1,200	800	2,900	(1)	5,000	400
Textile mill products	4,100	1,200	400	600	100	1,800	100
Lumber and wood products, except furniture	900	100	100	100	(1)	600	(1)
Paper and allied products	7,900	800	200	1,500	500	4,600	300
Chemicals and allied products	39,200	8,800	1,300	4,200	2,200	18,400	4,300
Industrial chemicals	26,200	6,000	600	2,100	1,200	12,900	3,400
Plastics and synthetics, except glass	4,400	1,100	300	600	500	1,700	200
Drugs	1,600	200	(1)	300	(1)	800	200
Agricultural chemicals	500	(1)	(1)	100	(1)	300	(1)
Other chemical products	6,400	1,500	300	1,000	400	2,700	500
Petroleum refining	14,100	1,700	200	2,500	1,000	6,700	1,900
Rubber and miscellaneous plastics products	5,800	1,200	400	1,000	700	2,200	300
Stone, clay, and glass products	7,500	1,400	600	1,300	1,000	2,900	300
Primary metal industries	22,700	2,600	600	4,600	2,100	11,600	1,200
Blast furnaces and basic steel products	14,400	1,500	300	3,100	1,300	7,300	900
Other primary metal industries	8,300	1,100	200	1,600	800	4,300	200
Fabricated metal products	22,700	3,900	1,500	4,400	4,100	7,700	1,100
Machinery, except electrical	64,000	18,600	4,700	8,900	10,800	17,800	3,100
Engines and turbines	3,600	1,200	200	500	500	1,000	100
Office, computing, and accounting machines	11,800	6,200	1,100	600	800	2,600	500
Farm machinery and equipment	7,100	2,300	500	1,200	700	2,000	400
Other machinery	41,500	8,900	2,800	6,500	8,800	12,200	2,200
Electrical equipment and supplies	112,000	49,200	7,500	10,600	14,700	25,000	5,000
Electric distribution equipment and industrial apparatus	23,800	7,900	1,600	2,800	4,800	5,800	800
Household appliances	3,500	1,300	300	400	100	1,200	100
Communication equipment	50,500	26,300	3,300	4,100	3,500	10,100	3,200
Electric lighting and wiring equipment	3,900	1,100	300	600	600	1,100	200
Electronic components and accessories	16,000	5,000	900	1,800	3,400	4,700	300
Radio and television receiving sets	9,900	6,100	800	400	1,300	1,000	300
Miscellaneous electrical equipment and supplies	4,500	1,400	200	500	1,000	1,200	200
Transportation equipment	100,100	46,000	7,200	9,400	5,300	29,500	2,600
Motor vehicles and equipment	20,800	6,800	1,200	3,400	1,200	7,700	500
Aircraft and parts	74,400	38,300	5,700	5,200	3,700	19,700	1,800
Other transportation equipment	4,900	900	300	900	300	2,100	400
Instruments and related products	25,500	9,600	2,300	2,100	3,200	7,300	1,100
Engineering and scientific instruments	10,200	4,500	1,300	800	700	2,600	400
Other instruments and related products	15,300	5,100	1,100	1,300	2,500	4,700	700
Other manufacturing industries	6,600	1,400	500	1,100	300	2,700	500
Nonmanufacturing	204,300	22,400	4,700	36,400	27,500	92,900	20,300
Mining	15,900	900	400	3,900	1,000	9,500	300
Metal mining	2,200	100	(1)	800	100	1,100	100
Coal mining	2,700	100	(1)	300	200	2,100	100
Crude petroleum and natural gas	9,500	500	300	2,500	500	5,600	(1)
Quarrying and nonmetallic mining	1,500	100	100	300	200	700	100
Contract construction	40,700	300	300	8,800	3,000	21,500	6,900
Transportation and public utilities	47,600	1,700	400	10,700	2,500	28,400	3,800
Railroad transportation	5,000	100	(1)	900	100	2,800	1,100
Communication	13,700	300	100	3,000	300	10,000	100
Electric, gas, and sanitary services	24,800	1,100	300	5,800	2,100	13,000	2,500
Other transportation	4,100	300	(1)	1,100	(1)	2,600	100
Wholesale and retail trade	23,500	1,300	200	4,300	13,400	3,500	800
Finance, insurance, and real estate	2,700	(1)	200	600	400	800	700
Services	73,900	18,200	3,300	8,100	7,200	29,300	7,800
Commercial laboratories; business and management consulting services	25,800	11,900	1,800	2,800	2,100	5,400	1,700
Medical and dental laboratories	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Engineering and architectural services	47,100	6,300	1,500	5,300	4,400	23,600	6,000
Other services	1,000	(1)	(1)	(1)	600	200	200
Agriculture, forestry, and fisheries	(1)	(1)	(1)	(1)	(1)	(1)	(1)

1 Less than 50 cases.

NOTE.—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962;* Bull. No. 1418.

TABLE III–54.—*Scientists and engineers primarily engaged in research and development in industry, by occupation, and as percent of all scientists and engineers, 1962*

Occupation	Number in research and development			Percent distribution [1]	R&D scientists and engineers as percent of all scientists and engineers [1]
	Performance	Management and administration	Total		
Total	256,600	47,200	303,800	100.0	35.7
Engineers	186,200	34,800	220,900	72.7	32.3
Physical scientists	60,900	10,400	71,300	23.5	52.6
Chemists	38,700	6,800	45,500	15.0	55.8
Physicists	10,000	1,800	11,800	3.9	84.9
Metallurgists	4,200	800	5,000	1.6	40.3
Geologists and geophysicists	900	300	1,200	.4	9.3
Mathematicians	7,100	700	7,800	2.6	53.1
Life scientists	7,900	1,500	9,400	3.1	35.5
Medical scientists	1,400	400	1,800	.6	23.4
Agricultural scientists	1,600	500	2,100	.7	24.4
Biological scientists	4,900	600	5,500	1.8	53.9
Other scientists (unclassified)	1,700	700	2,400	.8	48.0

[1] Estimates based on actual figures rather than rounded data shown.

NOTE—Detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

One indication of the utilization of scientists and engineers by industry is the ratio of technicians to scientists and engineers. In research and development, as table III–55 also shows, there was a considerable range in 1962 among different industries in the ratio of technicians to scientists and engineers. Among manufacturing industries, aircraft—the largest employer of R&D scientists and engineers and the second largest employer of R&D technicians—had a ratio (31 per 100) which was lower than the average for all industries combined. On the other hand, in the communication equipment industry—the largest employer of R&D technicians—the ratio of R&D technicians to R&D scientists and engineers was considerably above average. All nonmanufacturing industries combined had a higher-than-average ratio, affected primarily by the large numbers of technicians in the service industries.

Trends in Utilization of R&D Scientists and Engineers. Changes in the method of obtaining employment data in the various industry surveys make difficult a direct comparison of the changes over the past several years among the R&D scientists and engineers in the different occupational groups. (See previous discussion.) However, relative changes in the composition of the total group between 1959 and 1962 can be seen in table III–56. Only very slight changes occurred in the percent distribution of R&D scientists and engineers—a 1-percentage-point increase in chemists and a slightly larger decrease for engineers were the only significant changes.

For the 1-year period ending in January 1962, the 1-percent growth in R&D scientists and engineers was due primarily to the increase in numbers of engineers in R&D activities. (See table III–57.) R&D chemists, the largest scientific group, declined considerably more than the total chemist group. (See table III–9 and previous discussion on occupational change.) The large proportionate increases reported for the small groups of agricultural scientists and geologists and geophysicists may be due to a number of survey methodological factors.

TABLE III-55.—*Technicians primarily engaged in research and development, and ratio of R&D technicians to R&D scientists and engineers, by industry, 1962*

Industry	R&D technicians	R&D technicians per 100 R&D scientists and engineers
Total	151,000	50
Manufacturing	127,000	48
Ordnance and accessories	4,500	23
Food and kindred products	3,200	40
Textile mill products	1,900	53
Lumber and wood products, except furniture	(1)	(1)
Paper and allied products	1,100	42
Chemicals and allied products	17,500	44
Industrial chemicals	7,800	45
Plastics and synthetics, except glass	2,100	58
Drugs	2,900	34
Agricultural chemicals	100	9
Other chemical products	4,600	49
Petroleum refining	2,400	61
Rubber and miscellaneous plastics products	1,300	45
Stone, clay, and glass products	1,700	56
Primary metal industries	3,600	58
Blast furnaces and basic steel products	1,700	45
Other primary metal industries	1,900	79
Fabricated metal products	3,700	60
Machinery, except electrical	16,500	62
Engines and turbines	1,000	62
Office, computing, and accounting machines	5,200	57
Farm machinery and equipment	1,600	54
Other machinery	8,700	68
Electrical equipment and supplies	36,500	56
Electric distribution equipment and industrial apparatus	6,700	62
Household appliances	1,100	64
Communication equipment	17,900	54
Electric lighting and wiring equipment	900	55
Electronic components and accessories	4,100	52
Radio and television receiving sets	4,100	53
Miscellaneous electrical equipment and supplies	1,800	92
Transportation equipment	22,900	38
Motor vehicles and equipment	6,900	77
Aircraft and parts	15,300	31
Other transportation equipment	800	54
Instruments and related products	8,000	53
Engineering and scientific instruments	3,100	48
Other instruments and related products	4,900	58
Other manufacturing industries	2,100	70
Nonmanufacturing	24,000	63
Mining	600	28
Metal mining	200	58
Coal mining	200	103
Crude petroleum and natural gas	200	13
Quarrying and nonmetallic mining	100	25
Contract construction	100	9
Transportation and public utilities	800	33
Railroad transportation	(1)	(1)
Communication	200	55
Electric, gas, and sanitary services	400	28
Other transportation	100	39
Wholesale and retail trade	1,400	52
Finance, insurance, and real estate	(1)	(1)
Services	21,000	71
Commercial laboratories; business and management consulting services	14,100	70
Medical and dental laboratories	100	59
Engineering and architectural services	6,800	74
Other services	(1)	(1)
Agriculture, forestry, and fisheries	(1)	(1)

[1] Less than 50 cases.

NOTE.—Detail may not add to total because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

TABLE III-56.—*Percent distribution of scientists and engineers primarily engaged in research and development in industry, by occupation, 1959–62*

Occupation	1959	1960	1961	1962
Total	100.0	100.0	100.0	100.0
Engineers	74.2	74.1	72.5	72.7
Physical scientists	23.3	23.6	24.1	23.5
Chemists	14.0	14.2	15.8	15.0
Physicists	4.6	4.6	3.9	3.9
Metallurgists	1.9	2.0	1.7	1.6
Geogologists and geophysicists	.3	.3	.3	.4
Mathematicians	2.5	2.5	2.3	2.6
Life scientists	2.2	2.2	2.7	3.1
Medical scientists	.4	.4	.7	.6
Agricultural scientists	.5	.4	.4	.7
Biological scientists	1.3	1.3	1.7	1.8
Other scientists (unclassified)	.2	.2	.7	.8

NOTE.—Detail may not add to totals because of rounding.

Sources: National Science Foundation, *Scientific and Technical Personnel in American Industry—Report on a 1959 Survey*, NSF 60-62; *Scientific and Technical Personnel in Industry, 1960*, NSF 61-75; *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Full-Time-Equivalent Employment in Research and Development. A longer trend period in the employment of scientific and engineering personnel can be observed by comparing the full-time-equivalent employment of scientists and engineers in R&D activities. The full-time-equivalent number is equal to the number of scientists and engineers employed full time in the performance and administration of R&D, plus the number employed only part time in such work converted to a full-time basis. For example, two employees, each normally working in research and development for half the normal workweek, would equal one "full-time-equivalent" employee. The full-time-equivalent figure thus represents the total input of scientific and engineering personnel resources in R&D activities. Information on this full-time-equivalent employment comes primarily from National Science Foundation annual surveys of funds expended for industrial research and develop-

ment. A direct comparison of the 1961 and 1962 employment data from the R&D expenditures survey should not be made with the data from the 1961 and 1962 manpower industry surveys because of the different methodologies and concepts used to obtain information.

TABLE III-57.—*Scientists and engineers primarily engaged in research and development in industry, by occupation, 1961 and 1962*

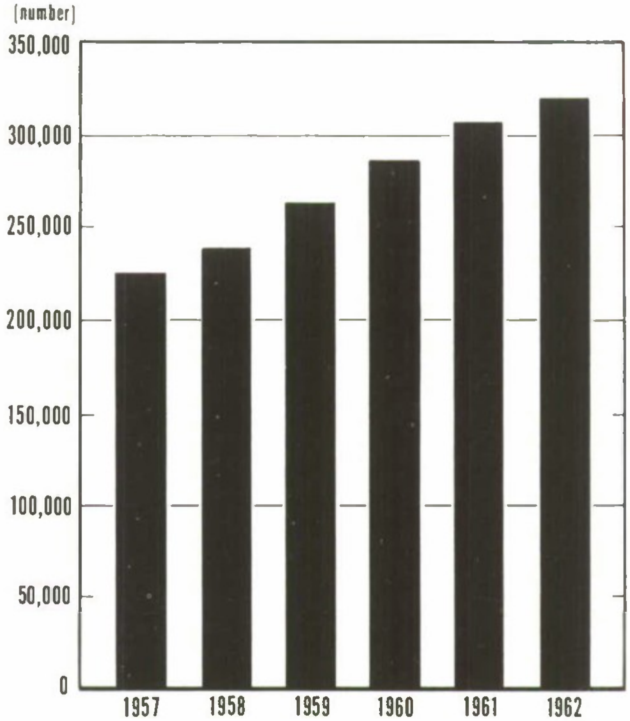
Occupation	Number employed: January 1961	Number employed: January 1962	Percent change
Total	301, 000	303, 800	0. 9
Engineers	218, 300	220, 900	1. 2
Physical scientists	72, 300	71, 300	—1. 4
Chemists	47, 600	45, 500	—4. 4
Physicists	11, 700	11, 800	. 9
Metallurgists	5, 100	5, 000	—2. 0
Geologists and geophysicists	800	1, 200	50. 0
Mathematicians	6, 900	7, 800	13. 0
Life scientists	8, 300	9, 300	12. 0
Medical scientists	2, 100	1, 800	—14. 3
Agricultural scientists	1, 200	2, 100	75. 0
Biological scientists	5, 100	5, 500	7. 8
Other scientists (unclassified)	2, 000	2, 400	20. 0

NOTE.—Detail may not add to totals because of rounding; percent change computed from unrounded data.

Sources: National Science Foundation, *Scientific and Technical Personnel in Industry, 1961*, NSF 63-32, and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in Industry, 1962*, Bull. No. 1418.

Although employment of R&D scientists and engineers has risen steadily since 1957, the rate of growth appears to have declined since 1959. In the period from January 1957 to January 1962, the full-time equivalent of industrial scientists and engineers engaged in research and development increased about 43 percent. For the 2-year period between 1957 and 1959, there was a rise of 17 percent which was followed by an increase of nearly 22 percent for the 3-year period ending in January 1962. (See table III-58 and chart III-10.)

Chart III-10. Growth in full-time-equivalent number of R&D scientists and engineers in industry, 1957–62



Source: National Science Foundation.

TABLE III-58.—*Full-time-equivalent number of scientists and engineers primarily engaged in research and development in industry, 1957–62*

Year [1]	Number	Percent change from previous year
1962	319, 800	4. 5
1961	306, 100	6. 9
1960	286, 300	9. 0
1959	262, 600	10. 2
1958	238, 400	6. 4
1957	224, 000	-----------

[1] As of January for each year.

Source: National Science Foundation, *Reviews of Data on Research & Development*, No. 40, "Research and Development in American Industry, 1962," NSF 63-37.

Functions of Science and Engineering Personnel in Colleges and Universities

Although teaching is the primary function of scientists and engineers employed in U.S. colleges and universities, many of them, primarily in universities with extensive graduate programs, en-

gage in a wide range of other activities, including research, administration, consultation, and extension work. The 1961 survey of colleges and universities conducted by the National Science Foundation obtained figures on the numbers employed full and part time in different functions.

Patterns in Colleges and Universities. Data from the 1961 survey show that well over two-fifths of the 175,600 scientists and engineers employed in colleges and universities were teaching and another one-fourth were in R&D work. (See table III–59.) Among faculty personnel, about 60 percent were concerned with teaching and only one-tenth as many with R&D activities. In contrast, about 70 percent of nonfaculty professional personnel were performing research and development, and less than one-tenth as many were in teaching. It should be further noted, however, that of the 39,300 faculty personnel reported engaged in a combination of activities, a fairly substantial number probably spent a portion of their time in research and development.[12]

Life scientists, the largest scientific occupational group employed in colleges and universities (63,200), had the smallest proportion of personnel primarily concerned with teaching—27 percent, compared with over 60 percent of the 36,000 social scientists and psychologists and 55 percent of the 49,100 physical scientists. On the other hand, more than 40 percent of the personnel in the life sciences, but only 17 percent of those in the physical sciences, were involved in a variety of activities which undoubtedly included some time spent in teaching. Among the individual fields in the physical and life sciences, the number and proportion of personnel engaged in different functions varied considerably. (See table III–60.)

R&D Personnel in Colleges and Universities. Data obtained from institutions of higher education in 1961 showed that 42,900 scientists and engineers, nearly 25 percent of the total number reported employed, were almost wholly engaged in R&D activities. As noted before, it should be borne in mind that many additional personnel who were engaged in a combination of activities undoubtedly spent some time in research and development. Furthermore, the 1961 survey of colleges and universities indicates that the bulk of R&D activities was undertaken in institutions granting graduate degrees in one or more fields of engineering, the physical and life sciences, social sciences, and psychology.

One-third of the engineers and more than one-fourth each of the physical scientists and the life scientists were primarily performing R&D work. In contrast, less than one-fifth of the psychologists and less than one-tenth of the social scientists were similarly engaged. Among the individual physical sciences and life sciences, the proportions

[12] The 1961 survey also provided data on the full-time-equivalent employment of scientists and engineers (including graduate students) in teaching, research and development, and other activities. See previous discussion for a definition of the full-time-equivalent concept used in industrial surveys. For discussion of the relationship between the total scientists and engineers employed and the full-time equivalent in different functions, refer to National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63–4.

TABLE III–59.—*Science and engineering professional personnel employed in colleges and universities,[1] by function and type of personnel, 1961*

Function	Total	Faculty	Nonfaculty professional personnel	Graduate students
All functions	175,600	108,100	32,500	35,000
Full time	115,000	87,200	27,800	----------
Part time	60,600	20,900	4,700	35,000
Teaching [2]	78,900	61,000	1,900	16,100
Full time	46,100	45,000	1,100	----------
Part time	32,900	16,000	800	16,100
Research and development [2]	42,900	6,200	22,100	14,600
Full time	25,100	5,300	19,800	----------
Part time	17,800	900	2,300	14,600
Other functions [2]	5,800	1,700	3,300	700
Full time	4,300	1,400	2,800	----------
Part time	1,500	300	500	700
Combined functions [3]	48,000	39,300	5,200	3,600
Full time	39,500	35,500	4,100	----------
Part time	8,500	3,800	1,100	3,600

[1] Includes Federal contract research centers and agricultural experiment stations with their associated colleges of agriculture.

[2] Personnel in these functions were reported as devoting all of their employed time to each of these functions respectively although some undoubtedly spent limited amounts of time in other functions. Those personnel reported in "other functions" were engaged in any one of several functions such as administration, extension work, etc.

[3] Personnel under "combined functions" were reported as engaged in a combination of two or more of the major functions reported.

NOTE.—Detail may not add to totals because of rounding.

Source: Data for "all functions" from National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4. Other data on employment by function based on unpublished materials from the 1961 survey, which provided data for the report cited.

TABLE III-60.—*Science and engineering professional personnel employed in colleges and universities,[1] by field and function, 1961*

Field	All functions			Teaching [2]			Research and development [2]			Other functions [2]			Combined functions [3]		
	Total	Full time	Part time	Total	Full time	Part time	Total	Full time	Part time	Total	Full time	Part time	Total	Full time	Part time
Total	175,600	115,000	60,600	78,900	46,100	32,900	42,900	25,100	17,800	5,800	4,300	1,500	48,000	39,500	8,500
Engineering	27,300	18,600	8,700	11,600	6,800	4,700	9,100	6,000	3,100	800	700	100	5,800	5,100	700
Physical sciences	49,100	30,000	19,100	26,600	14,600	12,100	13,200	7,900	5,300	700	400	300	8,500	7,000	1,500
Mathematics	14,800	9,500	5,300	10,600	6,200	4,300	1,800	1,200	600	200	100	100	2,200	2,000	300
Physics and astronomy	13,700	8,300	5,400	6,000	2,900	3,100	5,300	3,300	2,000	100	100	(4)	2,200	2,000	300
Chemistry	15,700	9,300	6,500	8,000	4,300	3,700	4,600	2,600	2,000	200	200	100	2,900	2,200	700
Earth sciences	3,900	2,300	1,600	1,700	900	800	1,200	600	600	100	100	100	1,000	800	200
Other	900	600	300	400	200	200	300	200	100	(4)	(4)	(4)	100	100	(4)
Life sciences	63,200	42,600	20,600	17,200	9,500	7,700	16,500	9,800	6,700	3,300	2,700	600	26,200	20,600	5,600
Biological sciences	31,100	21,300	9,800	11,800	7,400	4,400	8,500	4,800	3,600	900	700	200	9,900	8,400	1,600
Clinical sciences	23,400	14,800	8,600	4,300	1,300	3,000	4,400	2,900	1,400	1,500	1,200	300	13,100	9,400	3,800
Agricultural sciences	8,800	6,500	2,300	1,000	800	300	3,700	2,000	1,700	900	900	(4)	3,100	2,900	200
Social sciences	26,900	18,500	8,400	18,100	12,100	6,000	2,500	900	1,600	600	300	300	5,600	5,100	500
Psychology	9,200	5,300	3,900	5,500	3,100	2,400	1,500	500	1,000	400	100	200	1,900	1,600	300

[1] See footnote 1, table III-59.

[2] Personnel in these functions were reported as devoting all of their employed time to each of these functions respectively, although some undoubtedly spent limited amounts of time in other functions. Those personnel reported in "other functions" were engaged in any one of several functions such as administration, extension work, etc.

[3] Personnel under "combined functions" were reported as engaged in a combination of 2 or more of the major functions reported.

[4] Less than 50.

NOTE.—Detail may not add to totals because of rounding.

Source: Data for "all functions" from National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4. Other data on employment by function based on unpublished materials from the 1961 survey, which provided data for the report cited.

in research and development ranged from 13 percent in mathematics to 43 percent in agricultural sciences. (See table III-61). As indicated above, it appears that in some fields (e.g., clinical sciences) the proportion of personnel who engaged in research and development in addition to their primary function was substantial.

A heavy concentration of nonfaculty professional personnel devoted most of their time to research and development compared with the much smaller proportion of faculty personnel. (See tables III-59 and III-62.) In engineering, the physical sciences, and psychology, less than 10 percent of the R&D personnel were faculty members, compared with 20 percent or more in the social and life sciences, as shown in table III-62. In most colleges and universities proper (as distinguished from Federal contract research centers), faculty members were the principal investigators of research projects, and most of the other professional personnel (including graduate students) carried out their work under faculty direction.

R&D Scientific and Technical Personnel in the Federal Government

More than 50,800 scientists and engineers employed by the Federal Government in October 1962—more than one-third of all employed—were engaged in R&D activities. Information from a 1960 survey indicates that about 7 percent of these personnel were concerned primarily with planning and managing research and development.

Occupational Patterns in Research and Development. Although most of the natural science and engineering occupations had considerable numbers of personnel in research and development, the physical sciences, both as a whole and in almost all the individual occupations, had the largest proportions of R&D personnel. Over nine-tenths of the 4,600 physicists and half or more of the personnel in all the other physical sciences (with the outstanding exception of meteorology) were engaged in research and development. About half of the 7,200 biological scientists (notably those in bacteriology, entomology, and fishery biology) were in research and development, in contrast to about one-tenth of the agricultural scientists.

TABLE III-61.—*Science and engineering professional personnel engaged in research and development in colleges and universities,*[1] *by field, 1961*

Field	Number of employed personnel [2]		R&D as percent of total
	Total	Number in R&D [3]	
Total	175, 600	42, 900	25
Engineering	27, 300	9, 100	33
Physical sciences	49, 100	13, 200	27
Mathematics	14, 800	1, 800	13
Physics and astronomy	13, 700	5, 300	39
Chemistry	15, 700	4, 600	29
Earth sciences	3, 900	1, 300	33
Other	800	300	25
Life sciences	63, 200	16, 500	26
Biological sciences	31, 100	8, 500	27
Clinical sciences	23, 400	4, 400	18
Agricultural sciences	8, 800	3, 700	43
Social sciences	26, 900	2, 500	9
Psychology	9, 200	1, 500	16

[1] See footnote 1, table III-59.

[2] Full-time and part-time employment.

[3] Although personnel engaged in research and development were reported as devoting all of their time to this activity, some of them undoubtedly spent limited amounts of time in other functions.

NOTE.—Detail may not add to totals because of rounding.

Source: Total employment data from National Science Foundation, *Reviews of Data on Research & Development*, No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4. Other data on employment in research and development based on unpublished materials from the survey which provided data for the report cited.

In engineering, nearly two-thirds of the chemical, well over half of the mechanical, and nearly half of the electrical and electronic engineers were in research and development, compared with well under one-tenth of those employed in civil and industrial engineering. In mathematics, about half, and in psychology, about two-fifths, were engaged in research activities. Operations research, a classification established only a few years ago, was the smallest occupational group, but almost half were involved in research and development. (See table III-63.)

About 15,000 (16 percent) of the almost 93,400 technicians employed in Federal agencies were engaged in research and development. Of the R&D total, nearly three-fifths were engineering technicians. However, within any one occupational group, the highest proportions of R&D technicians were employed in mathematics and the biological sciences. (See table III-64.)

In 1962, the Department of Defense, largest Government employer of scientific and technical personnel, also had the largest R&D groups of scientists and engineers and technicians. Within the Defense agencies, the Department of the Navy employed more scientists and engineers (11,300) and technicians (about 3,600) in R&D work than any other single Federal department or agency for nearly one-fourth of the Government total. Outside of the military agencies, the National Aeronautics and Space Administration employed almost all of its 9,000 scientists and engineers, and almost 90 percent of its 1,400 technicians in research and development. Well over half of the

TABLE III-62.—*Science and engineering professional personnel engaged in research and development* [1] *in colleges and universities,*[2] *by type of personnel and field, 1961*

Type of personnel	Total [3]	Engineering	Physical sciences	Life sciences	Social sciences	Psychology
Total	42, 900	9, 100	13, 200	16, 500	2, 500	1, 500
Faculty	6, 200	900	1, 100	3, 500	500	100
Nonfaculty professional personnel	22, 100	5, 500	7, 400	8, 000	700	600
Graduate students	14, 600	2, 700	4, 700	5, 000	1, 300	800

[1] Although these personnel were reported as devoting all of their time to research and development, some of them undoubtedly spent limited amounts of time in other functions.

[2] See footnote 1, table III-59.

[3] Includes full-time and part-time employment; graduate students were employed on a part-time basis only.

NOTE.—Detail may not add to totals because of rounding.

Source: Unpublished data based on information obtained in National Science Foundation 1961 survey of science and engineering professional personnel in colleges and universities.

TABLE III-63.—*Scientists and engineers engaged in research and development in the Federal Government, by occupational group, October 1962*

Occupational group	Scientists and engineers	Number in R&D	R&D scientists and engineers as percent of total
Total	144, 122	50, 843	35. 3
Physical sciences	23, 043	16, 341	70. 9
Physics	4, 596	4, 237	92. 2
Geophysics, geology, and geodesy	2, 367	1, 226	51. 8
Chemistry	6, 789	4, 908	72. 3
Metallurgy	581	431	74. 2
Meteorology	2, 123	338	15. 9
Other [1]	6, 587	5, 201	79. 0
Mathematics [2]	5, 163	2, 576	49. 9
Engineering	67, 500	23, 502	34. 8
Civil	18, 304	1, 384	7. 6
Mechanical	17, 250	9, 605	55. 7
Electrical and electronic	14, 721	7, 028	47. 7
Chemical	1, 195	787	65. 9
Industrial	2, 175	125	5. 7
Other [3]	13, 855	4, 573	33. 0
Biological sciences	7, 212	3, 574	49. 6
Agricultural sciences (includes forestry)	16, 454	1, 532	9. 3
Health (selected categories) [4]	14, 640	1, 368	9. 3
Social sciences (selected categories) [5]	5, 479	921	16. 8
Geography and cartography	2, 389	100	4. 2
Psychology	1, 815	730	40. 2
Operations research	427	199	46. 6

[1] General physical sciences, astronomy and space sciences, technology, and other physical sciences.
[2] Actuary, mathematics, mathematical statistician, and statistics.
[3] General engineering, materials, safety, fire prevention, maintenance, architectural, mining, petroleum production and natural gas, agricultural, and welding engineering.
[4] Medical officer, dental officer, and veterinarian.
[5] Social science, economics, history, and anthropology.

Source: National Science Foundation, from U.S. Civil Service Commission data.

5,100 R&D scientists and engineers at the Department of Agriculture were in the biological and agricultural sciences, although chemists made up the largest single group of R&D scientists. In the Department of the Interior, of the 3,900 R&D scientists and engineers, over half were in the physical sciences (primarily geology) and over one-fourth were in engineering (chiefly civil engineering). (See tables III–65 and III–66 and chart III–11.)

TABLE III-64.—*Technicians engaged in research and development in the Federal Government, by selected occupational groups, October 1962*

Occupational group	Technicians	Number in R&D	R&D technicians as percent of total
Total	93, 354	14, 925	16. 0
Physical sciences	5, 946	2, 008	33. 8
Mathematics	565	458	81. 1
Engineering	41, 849	8, 362	20. 0
Biological sciences	2, 710	1, 824	67. 3
Agricultural sciences	10, 680	733	6. 9
Health (selected categories) [1]	9, 969	667	. 7
Mechanics	12, 848	732	5. 7
All other [2]	8, 787	141	1. 6

[1] Includes personnel classified as technicians, assistants, or aids in the health series (*e.g.*, medical technician, physical therapy assistant).
[2] Social sciences, geography-cartography, and psychology.

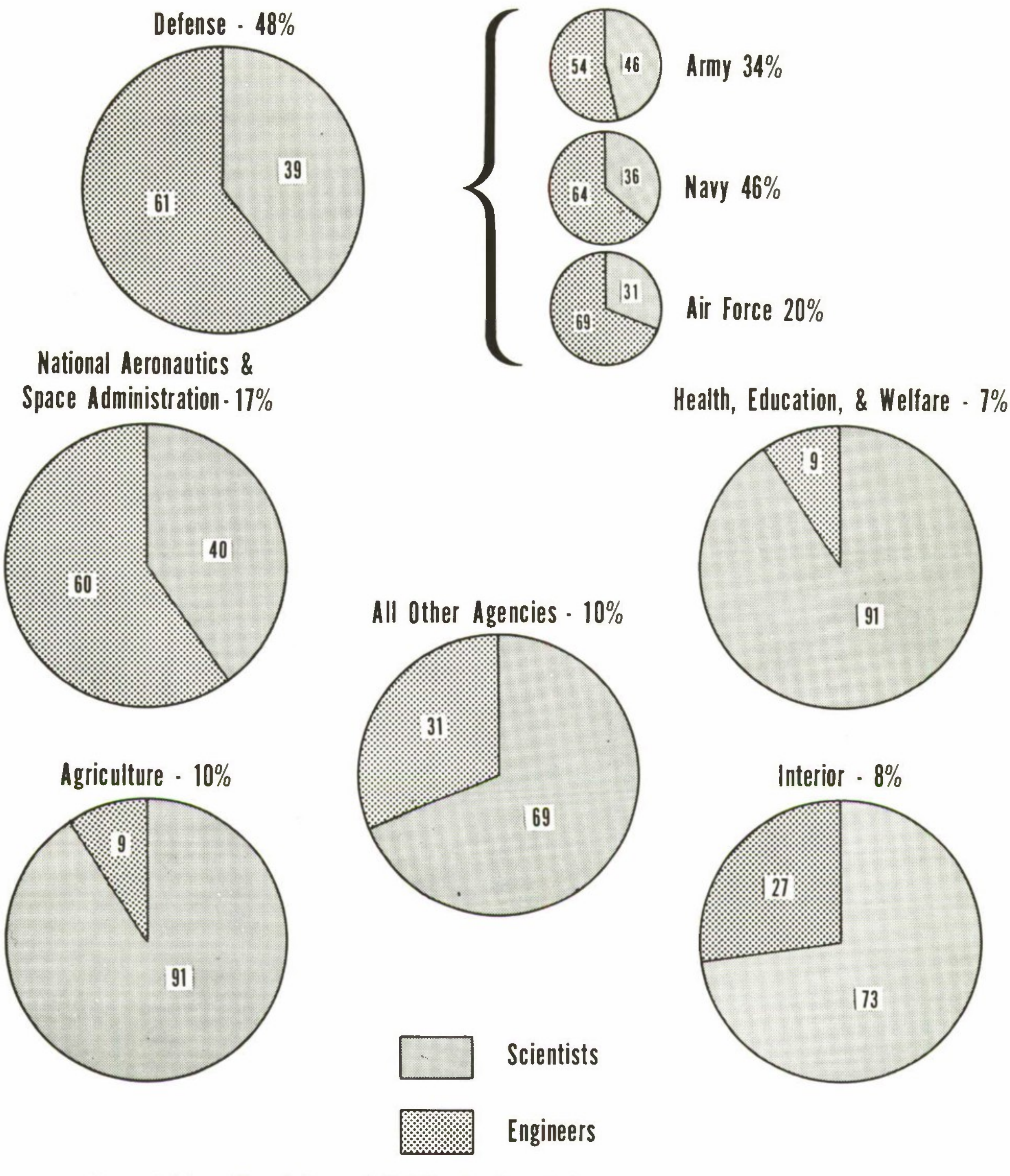
Source: National Science Foundation, from U.S. Civil Service Commission data.

Trends in Utilization of R&D Personnel. The Government's involvement in research and development activities in recent years is indicated by the trends in employment of R&D scientists and engineers. Overall, the number of scientists and engineers in research and development increased almost 22 percent between 1958 and 1962. An actual small decline between 1958 and 1959 was followed by much greater increases. (See table III–67.) Although almost all occupational groups increased from 1958 to 1962, the proportionate distribution changed somewhat during that period. (See chart III–12.)

The R&D physical scientist group increased in numbers in each successive period, except 1962, for an overall 4-year rise of almost 50 percent. The apparent decline in 1961–62 was due primarily to the fluctuations in numbers of personnel in the "other" physical sciences category. As discussed in more detail in the section on employment of all Government scientific and engineering personnel, the fluctuations were caused principally by the reclassification of large numbers of engineering personnel in NASA. Employment of engineering personnel in research and development increased in 1960 after declining the previous year and thereafter fluctuated in 1961 and 1962, primarily because of classification changes.

Chart III-11. R&D scientists and engineers employed in the Federal Government, by agency, October 1962

[Total R&D scientists and engineers: 50,843]



Sources: National Science Foundation and Civil Service Commission.

TABLE III-65.—*Scientists and engineers engaged in research and development in the Federal Government, by agency and occupational group, October 1962*

Agencies	Total	Physical sciences	Mathematics [1]	Engineering	Biological sciences	Agricultural sciences (including forestry)	Health (selected categories) [2]	Social sciences (selected categories) [3]	Geography and cartography	Psychology	Operations research
Total	50,843	16,341	2,576	23,502	3,574	1,532	1,368	921	100	730	199
Department of Defense, total	24,598	6,459	1,610	15,087	689	8	44	14	46	470	171
Office of the Secretary of Defense	69	29		33	1			1		3	2
Department of the Army	8,332	2,506	527	4,468	527	7	35	5	39	168	50
Department of the Navy	11,320	2,976	755	7,221	107	1	6		6	148	100
Department of the Air Force	4,877	948	328	3,365	54		3	8	1	151	19
Department of Health, Education, and Welfare	3,804	1,193	211	367	679	15	1,113	105		121	
Department of the Interior	3,871	2,142	22	1,032	595	11		21	47		1
Department of Agriculture	5,067	1,069	103	485	1,352	1,478	91	485	4		
Department of Commerce	2,176	1,341	243	553		1	1	18	3	11	5
Department of Labor	185		38	5				142			
Department of State	25							25			
Federal Aviation Agency	463	13	23	352	27		11	3		20	14
Atomic Energy Commission	534	171	3	336	18		5				1
National Aeronautics and Space Administration	8,571	3,273	262	5,018	2		4	7		5	
Tennessee Valley Authority	182	51	4	92	8	18		9			
Veterans Administration	798	437	19	9	146		99	5		83	
Other [4]	569	192	38	166	58	1		87		20	7

[1] Actuary, mathematics, mathematical statistician, and statistics.

[2] Medical officer, dental officer, and veterinarian.

[3] Social science, economics, history, and anthropology.

[4] Includes the remaining agencies of the executive branch, except the Central Intelligence Agency and National Security Agency; also includes the small numbers of scientific and engineering personnel employed by agencies of the legislative and judicial branches.

Source: National Science Foundation, from U.S. Civil Service Commission data.

TABLE III-66.—*Technicians engaged in research and development in the Federal Government, by agency and occupationa group, October 1962*

Agencies	Total	Physical sciences	Mathematics	Engineering	Biological sciences	Agricultural sciences (including forestry)	Health (selected categories) [1]	Social sciences (selected categories) [2]	Geography and cartography	Psychology	Mechanics
Total	14,925	2,008	458	8,362	1,824	733	667	3	122	16	732
Department of Defense, total	7,465	516	203	5,990	262	2	30		25	6	431
Office of the Secretary of Defense	2										2
Department of the Army	2,847	201	40	2,196	231	2	23		8	1	145
Department of the Navy	3,607	276	110	2,980	26		7		7	2	199
Department of the Air Force	1,009	39	53	814	5				10	3	85
Department of Health, Education, and Welfare	1,444	248	1	108	706	1	314			1	65
Department of the Interior	1,477	521	8	624	185		1	1	91		46
Department of Agriculture	1,524	281	4	190	301	727	6		2		13
Department of Commerce	683	264	3	323					2	1	90
Department of Labor	1							1			
Department of State											
Federal Aviation Agency											
Atomic Energy Commission	27	16		11							
National Aeronautics and Space Administration	1,430	66	237	1,054					1		72
Tennessee Valley Authority	36	10		21		3					2
Veterans Administration	809	79	1	26	370		316			8	9
Other [3]	29	7	1	15				1	1		4

[1] Includes personnel classified as technicians, assistants, or aids in the health series (e.g., medical technician, physical therapy assistant).

[2] Anthropology aid and economics assistant.

[3] Includes the remaining agencies of the executive branch, except the Central Intelligence Agency and National Security Agency; also includes the small numbers of scientific and engineering personnel employed by agencies of the legislative and judicial branches.

Source: National Science Foundation, from U.S. Civil Service Commission data.

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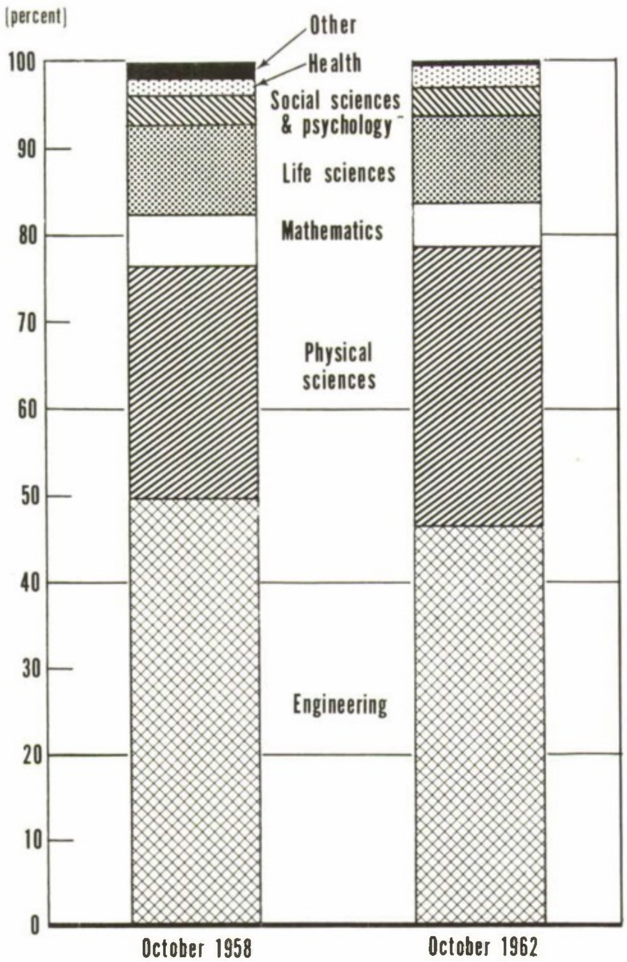
Chart III–12. R&D scientists and engineers employed in the Federal Government, by occupational group, 1958 and 1962



Sources: National Science Foundation and Civil Service Commission.

Employment of mathematicians in R&D underwent a sharp increase between 1961 and 1962 after nearly as large a decrease the preceding year. Health field researchers (M.D.'s, D.D.S.'s and D.V.M.'s, only) rose by about two-thirds over the 4-year period while psychologists increased one-third. Operations research, with very few personnel, increased more than 2½ times from 1958 to 1962.

Functions of Scientific and Engineering Personnel in State Government Agencies

Scientists and engineers employed by State government agencies in 1962 were utilized in a wide variety of functions, although almost half of the 48,000 personnel were primarily engaged in operations and services. Planning involved more than one-fifth of all scientific and engineering personnel, followed closely by inspection activities. Well under one-tenth of the scientists and engineers were primarily engaged in research and development and in "other activities" (e.g., technical writing).

Patterns in State Agencies. Among the engineers, nearly half were primarily engaged in operations and services, most of them civil engineers. More than one-third of all other engineers were also in this functional area. Geologists and geophysicists were the only occupational group, with the largest proportion (more than one-third) primarily engaged in research and development. More than one-fourth of the mathematicians and biological scientists also listed research and development as their primary function. Nearly two-fifths of the chemists were primarily engaged in inspection activities. However, among the remaining scientific occupations, more personnel were primarily engaged in operations and services than in any other function. (See table III–68.)

The employment of scientists and engineers in different functions varies considerably among the different State agencies. Because of the varied interpretations placed on definitions of functions by officials in similar agencies among the States, the data presented here should be considered as indicating relative magnitudes rather than precise figures.

In highway and public works agencies, with almost two-thirds of the State-employed scientists and engineers, nearly half were primarily engaged in operations and services, with another two-fifths divided between planning and inspection activities. (See table III–69.) Health and welfare agencies had the highest proportion (nearly one-fifth) of their scientific and engineering personnel in research. The largest number of scientists and engineers in "other agencies" [13] (nearly one-third) were in operations and services, with almost as large a proportion in the inspection function (the enforcement of laws, regulations, standards or programs).

[13] Agencies included were departments of motor vehicles, revenue, personnel, labor, public utilities, planning and development, finance, insurance, public safety, and correction.

TABLE III-67.—*Scientists and engineers engaged in research and development in the Federal Government, by occupational group and series, 1958 to 1962*

Occupational group	Number employed					Percent change				
	1958	1959	1960	1961	1962	1958–59	1959–60	1960–61	1961–62	1958–62
Total	41,827	40,865	43,282	45,903	50,843	−2.3	5.9	6.1	10.8	21.6
Physical sciences	[1] 11,086	11,447	12,062	[2] 17,071	[2] 16,341	3.3	5.4	[2] 41.5	[2] −4.3	[2] 47.4
Physics	3,181	3,345	3,674	3,622	4,237	5.2	9.8	−1.4	17.0	33.2
Geophysics, geology and geodesy	1,231	1,235	1,242	1,308	1,226	.3	.6	5.3	−6.3	−.4
Chemistry	4,195	4,127	4,074	4,394	4,908	−1.6	−1.3	7.9	11.7	17.0
Metallurgy	386	419	439	428	431	8.5	4.8	−2.5	.7	11.7
Meteorology	251	278	187	194	338	10.8	−32.7	3.7	74.2	34.7
Other [3]	1,842	2,043	2,446	[2] 7,125	[2] 5,201	10.9	19.7	[2] 191.3	[2] −27.0	[2] 182.4
Mathematics [4]	2,395	2,187	2,524	2,195	2,576	−8.7	15.4	−13.0	17.4	7.6
Engineering	[5] 20,780	19,802	21,099	[2] 18,965	[2] 23,502	−4.7	6.5	[2] −10.1	[2] 23.9	[2] 13.1
Civil	2,074	1,788	1,873	1,960	1,384	−13.8	4.8	4.6	−29.4	−33.3
Mechanical	7,430	6,794	7,870	5,725	9,605	−8.6	15.8	−27.3	67.8	29.3
Electrical and electronic	[5] 5,970	5,625	5,246	6,079	7,028	−5.8	−6.7	15.9	15.6	17.7
Chemical	708	734	694	703	787	3.7	−5.4	1.3	11.9	11.2
Industrial	145	121	153	92	125	−16.6	26.4	−39.9	35.9	−13.8
Other [6]	4,453	4,740	5,263	4,406	4,573	6.4	11.0	−16.3	3.8	2.7
Biological sciences	3,068	3,068	3,078	3,056	3,574	0.0	.3	−.7	17.0	16.5
Agricultural sciences (including forestry)	1,372	1,398	1,420	1,480	1,532	1.9	1.6	4.2	3.5	11.7
Health (selected categories)[7]	845	915	1,057	1,138	1,368	8.3	15.5	7.7	20.2	61.9
Social sciences (selected categories)[8]	826	866	828	707	921	4.8	−4.4	−14.6	30.3	11.5
Geography and cartography	842	589	440	410	[9] 100	−30.0	−25.3	−6.8	−75.6	[9] −88.1
Psychology	557	504	604	686	730	−9.5	19.8	13.6	6.4	31.1
Operations research	56	89	170	195	199	58.9	91.0	14.7	2.1	255.4

[1] Excludes 1,878 personnel classified in "electronic research, development and test" in 1958 as part of the physical science series who were transferred to "electronic engineering" to be consistent with the data for 1959 and 1960.

[2] Due to the reclassification of series that overlapped between some engineering series and "general physical science" in 1961, several thousand engineering personnel were transferred to the general physical science series. In 1962 many of these same personnel were transferred from "general physical science" back to engineering.

[3] Includes physical science administration (title changed to general physical science, February 1961), astronomy and space sciences, technology, and other physical sciences.

[4] Actuary, mathematics, mathematical statistician, and statistics.

[5] See footnote 1.

[6] General, materials, safety, fire prevention, maintenance, architectural, mining, petroleum production and natural gas, agricultural, and welding engineering.

[7] Medical officer, dental officer, and veterinarian; excludes related professional personnel such as nurses, public health administrators, dieticians, pharmacists, and therapists included in tables in other NSF reports (see source below).

[8] Social science, economics, history, and anthropological sciences.

[9] The decline in geography and cartography from 1961 to 1962 was due primarily to a reclassification of some cartographers into the nonprofessional geography series.

Sources: For 1958 and 1960: National Science Foundation, *Scientific and Technical Personnel in the Federal Government, 1959 and 1960*, NSF 62–26; for 1961, 1962, National Science Foundation, from U.S. Civil Service Commission data.

Employment in Research and Development. The significant involvement of State governments in R&D activities appears to be a recent development. The number of scientists and engineers employed in this function increased 42 percent from 1959 to 1962, or over twice as fast as total scientists and engineers employed by State governments. The proportion of the total employed in research and development remained small, however, growing from almost 6 percent in 1959 to 7 percent in 1962. Changes in the individual occupations varied widely from moderate declines to sharp increases. Engineers and biological scientists, the 2 largest individual occupations, accounted for more than two-thirds of the 1,000 increase over the 3-year span. (See tables III–69 and III–70.)

Changes in the numbers of scientists and engineers engaged in R&D activities between 1959 and 1962 also varied greatly among the State agencies. Highway and public works departments, which employed only a very small proportion (less than 3 percent) of their total scientists and engineers in research and development, more than doubled their R&D personnel in the 3-year period. By comparison, agriculture and conservation agencies, which employed the largest number of R&D scientists and engineers, had the smallest increase—about 16 percent. (See table III–71.)

TABLE III-68.—*Scientists and engineers employed in State agencies, by occupation and primary function, January 1962*

Occupation	All functions	Research and development	Planning	Inspection	Operations and services	Other
	Number					
Total	48, 029	3, 337	10, 247	8, 757	22, 942	2, 746
Engineers	33, 994	769	8, 810	6, 246	15, 989	2, 180
Civil	30, 047	607	7, 964	5, 268	14, 518	1, 690
Other engineers	3, 947	162	846	978	1, 471	490
Physical scientists	2, 727	780	314	622	906	105
Chemists	1, 381	318	61	519	437	46
Geologists and geophysicists	898	334	138	90	316	20
Mathematicians	448	128	115	13	153	39
Life scientists	10, 517	1, 629	1, 022	1, 860	5, 609	397
Biological scientists	4, 514	1, 256	415	644	2, 033	166
Agricultural scientists	4, 073	91	233	1, 037	2, 539	173
Medical scientists	1, 930	282	374	179	1, 037	58
Psychologists	517	112	46	3	327	30
Other scientists	274	48	55	26	111	34
	Percent					
Total	100. 0	6. 9	21. 3	18. 2	47. 8	5. 7
Engineers	100. 0	2. 3	25. 9	18. 4	47. 0	6. 4
Civil	100. 0	2. 0	26. 5	17. 5	48. 3	5. 6
Other engineers	100. 0	4. 1	21. 4	24. 8	37. 3	12. 4
Physical scientists	100. 0	28. 6	11. 5	22. 8	33. 2	3. 9
Chemists	100. 0	23. 0	4. 4	37. 6	31. 6	3. 3
Geologists and geophysicists	100. 0	37. 2	15. 4	10. 0	35. 2	2. 2
Mathematicians [1]	100. 0	28. 6	25. 7	2. 9	34. 1	8. 7
Life scientists	100. 0	15. 5	9. 7	17. 7	53. 3	3. 8
Biological scientists	100. 0	27. 8	9. 2	14. 3	45. 0	3. 8
Agricultural scientists	100. 0	2. 2	5. 7	25. 5	62. 3	4. 2
Medical scientists	100. 0	14. 6	19. 4	9. 3	53. 7	3. 0
Psychologists	100. 0	21. 5	8. 9	. 6	63. 2	5. 8
Other scientists	100. 0	17. 5	20. 1	9. 5	40. 5	12. 4

[1] Includes statisticians and actuaries.

NOTE.—Percent detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull No. 1412.

TABLE III-69.—*Distribution of scientists and engineers in State agencies, by agency and primary function, January 1962*

Agency	All functions	Research and development	Planning	Inspection	Operations and services	Other
	Number					
Total	48, 029	3, 337	10, 247	8, 757	22, 942	2, 746
Highway and public works	31, 600	830	8, 318	5, 525	14, 854	2, 073
Health and welfare	6, 243	1, 121	770	1, 049	3, 068	235
Agriculture and conservation	8, 301	1, 122	789	1, 663	4, 433	294
Other agencies	1, 885	264	370	520	587	144
	Percent					
Total	100. 0	6. 9	21. 3	18. 2	47. 8	5. 7
Highway and public works	100. 0	2. 6	26. 3	17. 5	47. 0	6. 6
Health and welfare	100. 0	18. 0	12. 3	16. 8	49. 1	3. 8
Agriculture and conservation	100. 0	13. 5	9. 5	20. 0	53. 4	3. 5
Other agencies	100. 0	14. 0	19. 6	27. 6	31. 1	7. 6

NOTE.—Percent detail may not add to totals because of rounding.

Source: U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

TABLE III-70.—*Scientists and engineers engaged in research and development in State agencies, by occupation, 1959 and 1962*

Occupation	Number		Percent change 1959–62
	January 1959	January 1962	
Total	2, 350	3, 337	42. 0
Engineers	369	769	108. 4
Physical scientists	395	780	97. 5
Chemists	202	318	57. 4
Geologists and geophysicists	145	334	130. 3
Mathematicians [1]	48	128	166. 7
Life scientists	1, 413	1, 629	15. 3
Biological scientists	977	1, 256	28. 6
Agricultural scientists	121	91	−24. 8
Medical scientists	315	282	−10. 5
Psychologists	151	111	−26. 5
Other scientists	22	48	118. 2

[1] Includes statisticians and actuaries.

Sources: National Science Foundation, *Employment of Scientific and Technical Personnel in State Government Agencies—Report on a 1959 Survey*, NSF 61-17; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

TABLE III-71.—*Scientists and engineers engaged in research and development in State agencies, by agency, 1959 and 1962*

Agency	Number		Percent change 1959–62
	January 1959	January 1962	
Total	2, 350	3, 337	42. 0
Highway and public works	382	830	117. 3
Health and welfare	920	1, 121	21. 8
Agriculture and conservation	968	1, 122	15. 9
Other	80	264	230. 0

Sources: National Science Foundation, *Employment of Scientific and Technical Personnel in State Government Agencies—Report on a 1959 Survey*, NSF 61-17; and U.S. Department of Labor, Bureau of Labor Statistics, *Employment of Scientific and Technical Personnel in State Government Agencies, 1962*, Bull. No. 1412.

In 1959, the only year for which detailed information on research activities was provided by State government agencies, about one-fourth of the total R &D scientists and engineers were reported conducting basic research.[14] Among the

[14] See National Science Foundation, *Employment of Scientific and Technical Personnel in State Government Agencies—Report on a 1959 Survey*, NSF 61-17, app. tables A-8 to A-12.

individual agencies, the proportions estimated to be in basic research were as follows:

Agency	*Percent R&D scientists and engineers in basic research*
Highway and public works	9.2
Health and welfare	32.4
Agriculture and conservation	25.8
Other agencies	30.0

Trends in Employment of R&D Scientists and Engineers in All Sectors

Data collected on the employment of scientists and engineers from the various sectors of the economy have been obtained at different times and, as stated previously, not always on a comparable basis. Some indication of recent overall trends comes from the estimates on employment of R&D personnel in 1954, 1958, and 1961.

By using the concept of full-time-equivalent employment (personnel employed full time in research and development plus the full-time equivalent of those employed part time in research and development) as an indicator of total manpower input, some comparisons can be made on the overall growth in four major sectors of the economy. In 1961, the total number of full-time-equivalent R&D scientists and engineers in these sectors was estimated to be 411,000—an increase of 84 percent over 1954. There was considerable variation in the rate of growth among the employing sectors. Colleges and universities had by far the greatest relative increase—more than 100 percent between 1954 and 1961. (See table III–72.) Industry, the largest employer of R&D scientists and engineers, had the greatest absolute increase, although the relative growth was about equal to the total for all four sectors combined. The smallest percentage increase occurred in the Federal Government where all R&D personnel are considered engaged in such work full time.

TABLE III–72.—*Full-time-equivalent number of scientists and engineers engaged in research and development,*[1] *by sector, 1954, 1958, and 1961*

Sector	Full-time equivalents [2]			Percent change 1954–61
	1954	1958	1961	
Total	223,200	326,200	411,100	84
Federal Government	29,500	[3] 40,400	[3] 44,500	51
Industry [4]	164,100	238,400	306,100	87
Colleges and universities	25,200	42,000	[5] 52,500	108
Other nonprofit institutions [4]	4,400	5,400	[5] 8,000	82

[1] Excludes social scientists and psychologists.

[2] Includes personnel employed full time in research and development plus the full-time equivalent of those employed part time in such activities.

[3] See table III–67.

[4] Includes professional R&D personnel employed at Federal contract research centers administered by organizations in the sector.

[5] National Science Foundation unpublished estimates.

NOTE.—Time periods for manpower data are composite designations covering a different survey date for each sector, within a given year, but generally reflecting the employment situation for a calendar year.

Sources: National Science Foundation, *Reviews of Data on Research & Development*, No. 33, "Trends in Funds and Personnel for Research and Development, 1953-61," NSF 62–9, and No. 40 "Research and Development in American Industry, 1962," NSF 63–37.

Technical Notes

The data on the employment of scientists, engineers, and technicians presented in this report were obtained primarily through surveys of employers in different sectors of the economy. Definitions of occupations and functions were provided survey respondents to obtain comparable data. The following definitions are generally applicable in all economic sectors, except where otherwise indicated.

Occupations

Engineers. All persons engaged in chemical, civil, electrical, mechanical, metallurgical, and other types of engineering work at a level which requires a knowledge of or training in engineering, physical, life, or mathematical sciences equivalent at least to that acquired through completion of a 4-year college course with a major in these fields. Includes all persons in research, development, production, management, technical service, technical sales, and other positions who have the equivalent of college training in their work. Does not include persons trained in engineering who are currently employed in jobs not requiring such training.

Scientists. All persons engaged in scientific work which requires a knowledge of or training in

physical, life, engineering, or mathematical sciences equivalent at least to that acquired through completion of a 4-year college course with a major in those fields. Includes all persons in research, development, production, management, technical service, technical sales, and other positions who have the equivalent of college training in science and are required to use this training in their work. Does not include persons trained in science but currently employed in positions not requiring such training.

Mathematicians. Persons whose position requires knowledge of mathematics equivalent at least to that acquired through a 4-year college course with a major in mathematics and who are primarily engaged in development or utilization of advanced mathematical techniques, including actuaries and mathematical analysts. Includes statisticians and programers for computers only if they specialize in mathematical techniques. Excludes accountants.

Medical scientists. Physicians, dentists, public health specialists, pharmacists, and members of other scientific professions concerned with the understanding of human diseases and improvement of human health, who are engaged in clinical investigation and other research, production, technical writing, and related activites. Excludes those primarily engaged in providing care to patients, dispensing drugs or services, diagnosis, etc., from all figures on scientists and engineers. Also excludes persons employed as pathologists, microbiologists, pharmacologists, etc., who were included in the biological scientists group.

Agricultural scientists. Scientists primarily engaged in understanding and improving agricultural productivity, such as those working in agronomy, animal husbandry, forestry, horticulture, range management, soil culture, and veterinary science. Excludes veterinarians primarily engaged in providing care to animals.

Biological scientists. All scientists, other than agricultural and medical scientists, who work in sciences which deal with life processes, including pathologists, microbiologists, pharmacologists, bacteriologists, toxicologists, botanists, zoologists, etc.

Earth scientists. Scientists primarily concerned with the study of the earth and its atmosphere, such as geologists, geophysicists, and meteorologists.

Technicians. All persons engaged in work requiring knowledge of physical, life, engineering, and mathematical sciences comparable to knowledge acquired through technical institute, junior college, or other formal post-high-school training, or through equivalent on-the-job training or experience. Some typical job titles are: Laboratory assistants, physical science aids, and electronic technicians. All employees in positions requiring the indicated level of knowledge and training are included regardless of job title and organizational unit in which employed. Excludes craftsmen such as machinists and electricians.

Functions

Definitions shown are generally applicable to work being performed by scientific and technical personnel in all economic sectors. Where separate functional areas were defined for a specific survey (e.g., State governments), it is so indicated.

Research and development. Includes basic and applied research in the sciences and engineering, and the design and development of prototypes and processes. Does not include quality control, routine product testing, market research, sales promotion, sales service, or other nontechnical activities or technical services. *In industry,* if the primary objective is to make further improvements on the products or process, then the work is research and development. If, on the other hand, the product or process is substantially "set" and the primary objective is to develop markets, do preproduction planning, or get the production process going smoothly, then the work is no longer research and development.

Basic research. Includes research which represents original investigation for the advancement of scientific knowledge. *In industry,* this was broadened to include research which does not have specific commercial objectives although it may be in fields of present or potential interest to the company.

Exploration. Includes the exploration and study of areas primarily for the purpose of locating minerals, fuels, and other natural resources. May involve such activities as drilling, examination of fossils, mapping, or specimen collection and analysis. Research on exploration techniques or instruments is classified under research and development.

Production and operations (industry definition). Work primarily related to the production processes or operations of a company such as inspection, quality control, etc. Include design, analysis, and testing that are not part of research and development.

Technical sales and service (industry definition). Includes technical sales work and/or providing technical services directly to customers. Exclude technical services provided to another part of the same company.

Operations and service (State government). Technical activity primarily related to the regular operation of government programs other than inspection. Include such activities as managing forests and parks; purchasing materials; letting contracts; constructing highways, hospitals, and other public works; controlling inspects; field exploration for minerals, fuels, and other natural resources, etc. Include testing, analysis, data collection, engineering, and design when they are part of a regular operating program or service other than inspection.

Planning (State government). Technical activity concerned with initiating or improving governmental programs, policies, legislation, and standards. Includes personnel engaged in such activities as planning new highways, developing health programs, initiating conservation projects, devising new construction programs, etc. Include testing, analysis, data collection, and preliminary engineering and design when these activities are part of planning.

Inspection (State government). Technical activity which deals with the enforcement of governmental laws, regulations, standards, or programs. Include testing, analysis, and data collection when they are part of inspection activities or are rendered as a service in connection with an inspection function.

Federal Government Occupational Series

The data on employment of scientific and technical personnel are based on the numbers of personnel in the Civil Service occupational series. The following list outlines the selected occupational series used in this publication for reporting professional science and engineering personnel in 1962.

BIOLOGICAL SCIENCES

GS 401 Biology (general)
GS 403 Microbiology
GS 420 Bacteriology

Animal Sciences

GS 410 Zoology
GS 411 Systematic zoology
GS 412 Parisitology
GS 413 Physiology
GS 414 Entomology

Plant Sciences

GS 415 Nematology
GS 430 Botany
GS 431 Mycology
GS 433 Plant taxomony
GS 434 Plant pathology
GS 435 Plant physiology
GS 436 Plant quarantine and pest control

Fishery and Wildlife Sciences

GS 480 General fish and wildlife administration
GS 482 Fishery biology
GS 484 Animal control biology
GS 485 Wildlife refuge management
GS 486 Wildlife biology

Other Biological Sciences

GS 405 Pharmacology
GS 440 Genetics
GS 452 Park naturalist
GS 454 Range conservation
GS 493 Home economics
GS 494 Microanalysis
GS 1382 Food technology

AGRICULTURAL SCIENCES

GS 406 Agricultural extension service
GS 471 Agronomy
GS 437 Horticulture
GS 450 General agricultural administration
GS 451 General agriculture
GS 457 Soil conservation
GS 470 Soil science
GS 475 Farm management loan
GS 487 Husbandry

Forestry

GS 460 Forestry
GS 1380 Forestry products technology

HEALTH

GS 602 Medical officer
GS 680 Dental officer
GS 701 Veterinary officer

PHYSICAL SCIENCES

GS 1301 General physical sciences
GS 1310 Physics
GS 1313 Geophysics
GS 1320 Chemistry
GS 1321 Metallurgy
GS 1330 Astronomy and space science
GS 1340 Meteorology
GS 1350 Geology
GS 1372 Geodesy
GS 1390 Technology
GS 1306 Health physics
GS 1360 Nautical sciences
GS 1384 Textile technology

GEOGRAPHY AND CARTOGRAPHY

GS 150 Geography
GS 1370 Cartography
GS 1373 Cadastral surveying

ENGINEERING SCIENCES

GS 801 General engineering
GS 806 Materials engineering

Civil Engineering

GS 810 Civil engineering
GS 811 Construction engineering
GS 812 Structural engineering
GS 813 Hydraulic engineering
GS 819 Sanitary engineering
GS 820 Highway engineering
GS 824 Bridge engineering
GS 862 Airways engineering

Mechanical Engineering

GS 830 Mechanical engineering
GS 832 Automotive engineering
GS 840 Nuclear engineering
GS 861 Aerospace engineering
GS 870 Marine engineering
GS 871 Naval architecture

Electric and Electronic Engineering

GS 850 Electrical engineering
GS 855 Electronic engineering

Chemical Engineering

GS 892 Ceramic engineering
GS 893 Chemical engineering

Industrial Engineering

GS 896 Industrial engineering
GS 897 Valuation engineering

All Other Engineering

GS 803 Safety engineering
GS 804 Fire prevention engineering
GS 805 Maintenance engineering
GS 808 Architecture
GS 880 Mining engineering
GS 881 Petroleum production and natural-gas engineering
GS 890 Agricultural engineering
GS 894 Welding engineering

MATHEMATICAL SCIENCES

GS 1510 Actuary
GS 1520 Mathematics
GS 1529 Mathematical statistician
GS 1530 Statistics

SOCIAL SCIENCES

GS 101 Social science

Economics

GS 110 General economics
GS 111 Business economics
GS 112 International trade and development economics
GS 113 Fiscal and financial economics
GS 115 Transportation economics
GS 116 Labor economics
GS 117 Agricultural economics
GS 135 Foreign agricultural affairs

History

GS 170 History

Anthropological Sciences

GS 190 General anthropology
GS 192 Physical anthropology
GS 193 Archaeology
GS 194 Ethnology
GS 195 Scientific linguistics

PSYCHOLOGY

GS 180 Psychology

OPERATIONS RESEARCH

GS 015 Operations research

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No. 40, "Research and Development in American Industry, 1962: A Preliminary Report on R&D Scientists and Engineers (Jan. 1963) and R&D Funds," NSF 63-37. September 1963.

No. 37, "Science and Engineering Professional Manpower Resources in Colleges and Universities, 1961. A Preliminary Report," NSF 63-4. January 1963.

No. 35, "Scientific Research and Other Programs of Private Foundations, 1960," NSF 62-28. August 1962.

No. 33, "Trends in Funds and Personnel for Research and Development, 1953-61," NSF 62-9. April 1962.

No. 29, "Scientists and Engineers in Research and Development, 1958," NSF 61-49. August 1961.

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Chapter IV. BACKGROUNDS AND CHARACTERISTICS OF SCIENTISTS AND ENGINEERS

INFORMATION on the professional, personal, and economic characteristics of the Nation's resources of scientific and technical personnel is important for planning and evaluating programs concerned with improving and increasing the supply of qualified scientific manpower. Since the available data were obtained from a number of different studies and surveys, not all using the same methodology, definitions, and concepts, the results are not always entirely comparable. However, such information helps to provide an overall picture of the backgrounds and characteristics of the Nation's scientists and engineers.

The National Register of Scientific and Technical Personnel, which has been maintained by the National Science Foundation since 1953 as a statutory responsibility, represents one of the basic sources of up-to-date background information on the Nation's scientific manpower resources. The National Register provides detailed professional, personal, and economic data on personnel in the sciences. Cooperating scientific societies circulate questionnaires every 2 years to individual scientists, members and nonmembers alike, in an attempt to obtain as wide a coverage as possible.[1]

In 1962, the National Register questionnaire was accompanied by a list of nearly 900 scientific specialities from which the registrants were requested to select up to 4 in order of their particular professional competence.[2] The data appearing in the tables for Register personnel are, however, related to their first field of professional competence.

The National Register has been almost entirely restricted to the sciences and until 1964 did not undertake a registration of engineers, except for the field of sanitary engineering.[3] Some meaningful information on various characteristics of engineers is available from other Government sources, such as the Bureau of the Census and Bureau of Labor Statistics, and is included within this chapter whenever appropriate.

Employment Status of Scientists

Of the 214,940 registrants in the National Register in 1962, 89 percent were employed full time in professional scientific work. Most were civilians, but about 4,000 and 1,000, respectively, were on active duty with the Armed Forces and the U.S. Public Health Service. A high percentage of scientists in each field was employed full time in the civilian economy; only in meteorology was a substantial proportion of scientists (42 percent) in military service. (See table IV–1.) The next largest group, about 6 percent of the total, was students. These usually were experienced scientists working for advanced degrees (many for the Ph. D.), and some were on postdoctoral fellowships. In physics and astronomy, about 14 percent of the Register scientists classified themselves as students.

Almost 3,200 of the 1962 registrants were employed only part time (not including students), and nearly 3,500 were employed in other than professional scientific work. The latter group includes persons trained as scientists but currently employed in some other field. As such, they form a part of the Nation's scientific potential, as do most of the 1,300 (less than 1 percent of the total) who gave no report on employment and some of those who were actually unemployed in 1962 (either retired or actively seeking employment).

[1] Cooperating societies in 1962 included American Chemical Society, American Geological Institute, American Institute of Biological Sciences, American Institute of Physics, American Mathematical Society, American Meteorological Society, American Psychological Association, and Federation of American Societies for Experimental Biology, and through these organizations about 200 specialized societies. The U.S. Public Health Service cooperated in the registration of sanitary engineers.

[2] See Technical Notes for Specialties List used with National Register questionnaire.

[3] For 1964, a partial register of the engineering community has been undertaken through the efforts of the National Science Foundation in cooperation with the Engineers Joint Council. Questionnaires have been mailed to 100,000 engineers representing 1 in 6 of all members of national engineering societies.

TABLE IV-1.—*Employment status of scientists in the National Register, by field, 1962*

Scientific and technical fields	Number of scientists	Percent distribution									
		Total	Employed full time				Employed part time	Students	Employed in other than professional work	Unemployed [1]	No report
			Total	Civilian	Military	Commissioned Corps, PHS					
All fields	214,940	100.0	88.6	86.2	2.1	0.4	1.5	6.1	1.6	1.6	0.6
Agricultural sciences	12,389	100.0	88.3	88.1	.2	(2)	.8	5.1	3.5	1.4	.8
Biological sciences	25,554	100.0	86.3	83.3	1.4	1.6	2.8	7.0	1.0	1.7	1.2
Psychology	16,791	100.0	88.2	86.7	1.3	.2	4.6	3.7	.7	2.6	.2
Earth sciences	18,725	100.0	86.7	86.0	.7	(2)	1.1	7.1	2.3	2.5	.3
Meteorology	5,379	100.0	92.5	50.4	42.1	(2)	.6	3.6	2.0	1.0	.2
Mathematics and statistics	18,189	100.0	91.1	89.8	1.1	.1	1.2	5.4	1.1	.6	.7
Physics and astronomy	25,725	100.0	82.7	80.9	1.7	(2)	1.0	13.8	1.0	1.3	.2
Chemistry	54,130	190.0	89.8	89.2	.4	.2	1.0	5.5	1.2	1.7	.7
Sanitary engineering	4,923	100.0	94.3	87.2	1.4	5.7	.9	2.2	1.1	.6	1.0
Other fields	33,135	100.0	91.8	90.2	1.5	.1	.9	2.6	2.8	1.3	.6

[1] Unemployed includes retired, housewife, etc.

[2] Less than 0.05 percent.

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Geographic Distribution

Scientists

The largest proportion of all full-time employed scientists in the National Register reported from the Middle Atlantic States (New Jersey, New York, and Pennsylvania). The smallest proportion reported from the East South Central area covering Alabama, Kentucky, Mississippi, and Tennessee. This geographic distribution is based on the geographic divisions used by the Bureau of the Census. Except for the East South Central area, which has only about half its proportionate share, the general distribution varies only slightly from that of the total U.S. population.[4] Almost three-fifths of the scientists were located in the east and west coast areas of the United States. (See table IV-2 and chart IV-1.)

The geographic distribution of scientists in some scientific and technical fields vary considerably from the overall pattern. Earth scientists, for example, were most heavily concentrated in the West South Central, Mountain, and Pacific divisions—areas in which much of the Nation's petroleum and mineral resources are located. Over half of the agricultural scientists were located in the Southern and Western States—17 percent in the South Atlantic division and 37 percent in the Mountain and Pacific divisions. The Middle Atlantic and East North Central divisions contained about half of those in chemistry—explained in large measure by the heavy concentrations of the chemical industry and many institutions of higher education in these areas. Almost 21 percent of the meteorologists were reported in the South Atlantic division, which includes the Washington, D.C., area where a substantial number are employed in the U.S. Weather Bureau. About 8 percent of the total meteorologists were in the Armed Forces stationed in foreign areas as military meteorologists. (See table IV-3.)

Another means of focusing on the geographic distribution of scientific personnel is to examine their location in complex urban areas known as Standard Metropolitan Statistical Areas (SMSA's).[5] Nearly half of the scientists reporting to the National Register were employed in 25 of some 200 SMSA's in the United States. About half of these, or 23 percent of the Register total, were concentrated in five areas—New York, N.Y.; Washington, D.C.-Md.-Va.; Los Angeles-Long Beach, Calif.; Chicago, Ill.; and Boston, Mass. (See table IV-4.)

The distribution of scientific personnel by their highest degree varied among the SMSA's. For the 25 selected SMSA's as a whole, 34 percent of the scientists had bachelor's degrees and about 32 percent had Ph.D. degrees. The

[4] See U.S. Department of Commerce, Bureau of the Census, *Current Population Reports*, series P-25, No. 258, *Estimates of the Population of States and Selected Outlying Areas of the United States: July 1, 1961 and 1960.*

[5] Generally, SMSA's include cities of 50,000 or more population, together with adjacent counties or other political units, in which factors such as volume of commuting, the character of the labor force, and existence of joint planning organizations are considered.

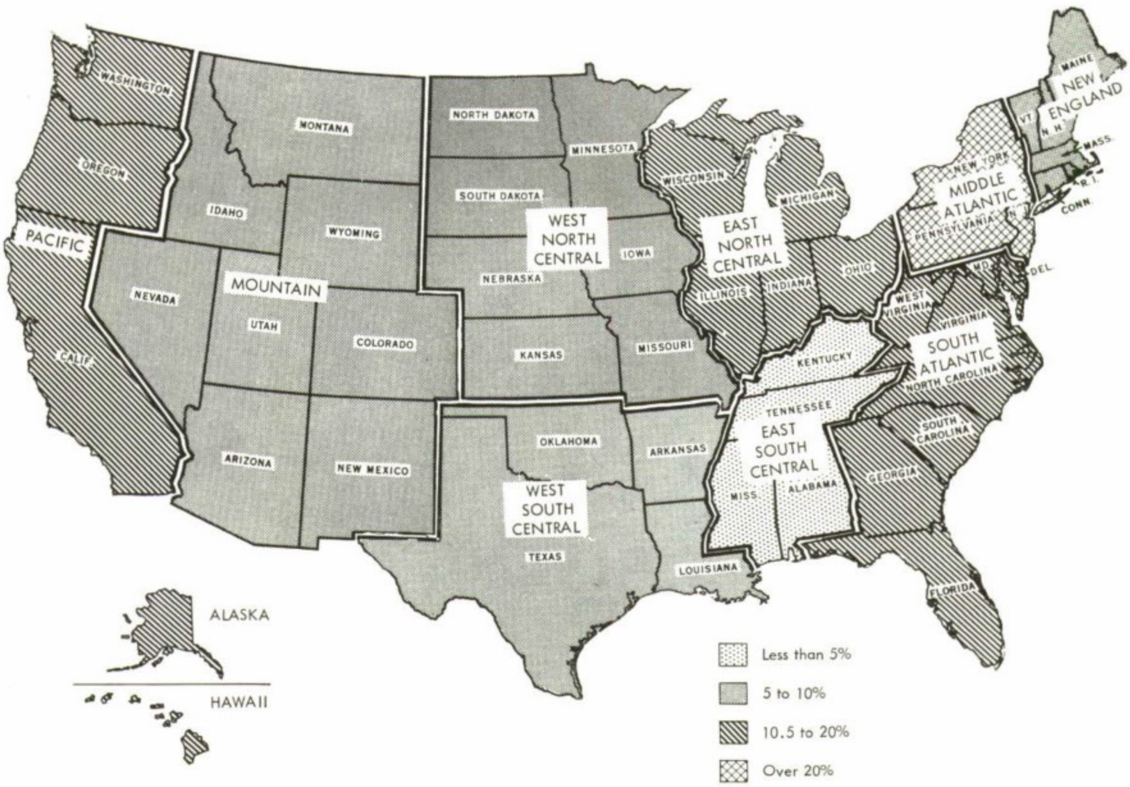
TABLE IV-2.—*Employed scientists in the National Register, by region and State, 1962*

Region and State	Number	Percent
All regions	214, 940	100. 0
New England	14, 993	7. 0
Connecticut	3, 997	1. 9
Maine	635	. 3
Massachusetts	8, 694	4. 0
New Hampshire	584	. 3
Rhode Island	768	. 4
Vermont	315	. 1
Middle Atlantic	47, 562	22. 1
New Jersey	11, 549	5. 4
New York	23, 496	10. 9
Pennsylvania	12, 517	5. 8
East North Central	35, 535	16. 6
Illinois	10, 790	5. 0
Indiana	4, 225	2. 0
Michigan	7, 143	3. 3
Ohio	9, 816	4. 6
Wisconsin	3, 561	1. 7
West North Central	13, 650	6. 3
Iowa	2, 051	1. 0
Kansas	2, 011	. 9
Minnesota	3, 614	1. 7
Missouri	3, 888	1. 8
Nebraska	1, 109	. 5
North Dakota	495	. 2
South Dakota	482	. 2
South Atlantic	29, 671	13. 8
Delaware	2, 327	1. 1
District of Columbia	6, 512	3. 0
Florida	3, 449	1. 6
Georgia	2, 090	1. 0
Maryland	6, 568	3. 1
North Carolina	2, 740	1. 3
South Atlantic—Continued		
South Carolina	1, 117	. 5
Virginia	3, 389	1. 6
West Virginia	1, 479	. 7
East South Central	7, 269	3. 4
Alabama	1, 784	. 8
Kentucky	1, 444	. 7
Mississippi	1, 065	. 5
Tennessee	2, 976	1. 4
West South Central	18, 181	8. 5
Arkansas	800	. 4
Louisiana	3, 234	1. 5
Oklahoma	3, 147	1. 5
Texas	11, 000	5. 1
Mountain	12, 114	5. 7
Arizona	1, 463	. 7
Colorado	3, 766	1. 8
Idaho	872	. 4
Montana	940	. 4
Nevada	440	. 2
New Mexico	2, 200	1. 0
Utah	1, 663	. 8
Wyoming	770	. 4
Pacific	32, 971	15. 3
Alaska	516	. 2
California	25, 526	11. 9
Hawaii	634	. 3
Oregon	2, 438	1. 1
Washington	3, 857	1. 8
Foreign	2, 994	1. 4

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Chart IV-1. Scientists employed in the United States, by region, 1962



Source: National Science Foundation.

TABLE IV-3.—*Scientists in the National Register, by field and geographic division, 1962*

Scientific and technical field	Number of scientists	Percent distribution by geographic division										
		Total	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific	Foreign
All fields	214,940	100.0	7.0	22.1	16.5	6.4	13.8	3.4	8.5	5.6	15.3	1.4
Agricultural sciences	12,389	100.0	3.9	6.8	11.4	9.5	16.7	5.9	8.1	15.2	21.6	.9
Biological sciences	25,554	100.0	7.2	20.3	18.4	8.0	17.4	3.6	5.7	4.3	13.9	1.2
Psychology	16,791	100.0	7.6	27.2	18.6	7.3	11.8	2.5	4.5	3.4	16.2	.9
Earth sciences	18,725	100.0	2.8	6.8	8.2	5.5	8.7	3.0	31.4	14.3	14.1	5.2
Meteorology	5,379	100.0	7.1	11.4	8.9	7.6	20.5	2.5	7.4	8.9	18.0	7.7
Mathematics and statistics	18,189	100.0	8.3	23.1	15.1	6.4	15.2	2.6	5.1	4.5	18.9	.8
Physics and astronomy	25,725	100.0	10.4	24.8	14.1	4.3	13.3	2.8	4.1	5.3	20.0	.9
Chemistry	54,130	100.0	7.4	29.2	21.2	5.8	13.2	3.6	6.3	2.6	10.3	.4
Sanitary engineering	4,923	100.0	6.2	19.0	20.3	8.5	14.6	3.5	6.8	4.0	15.4	1.7
Other fields	33,135	100.0	5.9	23.4	16.4	5.8	13.2	3.7	9.0	4.9	16.6	1.1

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-4.—*Scientists in the National Register, by selected Standard Metropolitan Statistical Area, 1962*

Geographic location	Number	Percent
All locations	214, 940	100. 0
Selected SMSA's	103, 283	48. 1
New York, N.Y	14, 513	6. 8
Washington, D.C.-Md.-Va	10, 712	5. 0
Los Angeles-Long Beach, Calif	10, 266	4. 8
Chicago, Ill	7, 501	3. 5
Boston, Mass	6, 611	3. 1
Philadelphia, Pa.-N.J	6, 483	3. 0
San Francisco-Oakland, Calif	6, 295	2. 9
Newark, N.J	4, 405	2. 0
Pittsburgh, Pa	3, 205	1. 5
Houston, Tex	2, 832	1. 3
Minneapolis-St. Paul, Minn	2, 729	1. 3
Denver, Colo	2, 701	1. 3
Cleveland, Ohio	2, 520	1. 2
Wilmington, Del.-N.J	2, 470	1. 1
St. Louis, Mo.-Ill	2, 345	1. 1
Detroit, Mich	2, 330	1. 1
San Jose, Calif	2, 330	1. 1
Baltimore, Md	1, 856	. 9
Seattle, Wash	1, 848	. 9
Columbus, Ohio	1, 619	. 8
Rochester, N.Y	1, 576	. 7
Cincinnati, Ohio-Ky	1, 571	. 7
Buffalo, N.Y	1, 562	. 7
Albany-Schenectady-Troy, N.Y	1, 530	. 7
Dallas, Tex	1, 473	. 7
Other locations	111, 657	51. 9

NOTE.—Percent detail may not add to selected SMSA'S total because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

proportions of these advanced-degree holders ranged from more than 50 percent in the Wilmington, Del., area to less than 25 percent in the Dallas and Houston, Tex., areas. (See table IV-5.)

Engineers

Data on the location of engineering personnel are available from information collected in the 1960 Census of Population. Over two-fifths of the engineers were in the East North Central and Middle Atlantic regions, with about equal numbers in each area. The Pacific region had less than one-fifth of all engineers, most of them located in California. (See table IV-6 and chart IV-2.) Engineers, like the scientists (table IV-2), were concentrated in the east and west coast areas—with nearly three-fifths of the total.

Engineers by field of specialization varied considerably in their distribution patterns. More than two-fifths of the aeronautical engineers were located in the Pacific region, reflecting the heavy concentration of the aircraft and missiles industry in California. On the other hand, almost three-fifths of the mining engineers were employed in the West South Central and Mountain regions, where the bulk of petroleum and mineral deposits are located. About half of the mechanical and industrial engineers, and over three-fifths of the metallurgical engineers were employed in the East North Central and Middle Atlantic regions, where much of the Nation's heavy manufacturing industry is located. (See table IV-7).

Of the 15 Standard Metropolitan Statistical Areas in which 10,000 or more engineers were located, more than two-fifths of all employed male engineers lived in these SMSA's. Over one-fifth of all male engineers were concentrated in four areas—Los Angeles-Long Beach, Calif.; New York, N.Y.; Chicago, Ill.; and Philadelphia, Pa. (See table IV-8.) The States in which these SMSA's are located accounted for somewhat less than two-fifths of the engineering population.

Level of Education of Scientists

An analysis of the educational background of the scientists in the 1962 National Register indicates that formal education beyond the undergraduate degree is becoming the standard among scientific personnel. Almost three-fifths of all registrants had attained graduate degrees—26 percent held the master's as their highest degree, and 31 percent held the Ph.D. or equivalent degree (Sc. D., Ed. D., etc.).

The single largest group of registrants held only the bachelor's degree (37 percent), although there are wide variations among scientific fields. (See table IV-9.) In the agricultural and earth sciences and in the sanitary engineering field, about half or more of the scientists held the bachelor's degree, compared with less than one-fifth who had attained the Ph.D. On the other hand, the largest number of scientists in the biological sciences, psychology, and physics and

TABLE IV-5.—*Percent distribution of scientists in the National Register, by selected Standard Metropolitan Statistical Area and highest degree, 1962*

Area	Total	Less than bachelor's degree	Bachelor's	Master's	Professional medical	Ph. D.	No report
All locations	100.0	2.7	36.6	26.4	2.6	30.8	1.0
Selected SMSA's	100.0	2.4	34.4	26.1	3.7	32.4	1.0
New York, N.Y	100.0	2.3	30.4	28.6	5.5	32.2	1.1
Washington, D.C.-Md.-Va	100.0	3.6	31.6	25.8	4.5	34.0	.6
Los Angeles-Long Beach, Calif	100.0	3.4	35.2	27.4	2.2	31.0	.9
Chicago, Ill	100.0	1.6	34.2	27.0	3.9	32.1	1.2
Boston, Mass	100.0	1.9	26.9	27.7	6.1	36.5	.9
Philadelphia, Pa-N.J	100.0	2.2	35.8	25.2	5.1	30.1	1.6
San Francisco-Oakland, Calif	100.0	3.3	35.4	22.4	2.8	34.9	1.2
Newark, N.J	100.0	1.5	35.8	25.9	.8	34.7	1.3
Pittsburgh, Pa	100.0	1.0	38.5	24.0	2.0	33.3	1.3
Houston, Tex	100.0	4.2	49.8	23.3	1.6	20.2	.9
Minneapolis-St. Paul, Minn	100.0	1.4	37.0	23.6	2.8	34.3	1.0
Denver, Colo	100.0	3.3	43.0	27.0	1.8	23.9	1.0
Cleveland, Ohio	100.0	1.8	37.2	26.8	5.0	28.4	.8
Wilmington, Del.-N.J	100.0	.7	26.4	18.7	.2	53.4	.6
St. Louis, Mo.-Ill	100.0	4.1	38.4	24.0	4.6	27.4	1.6
Detroit, Mich	100.0	2.7	36.2	30.3	2.4	27.5	.9
San Jose, Calif	100.0	1.7	30.1	27.1	2.4	38.4	.3
Baltimore, Md	100.0	2.9	33.3	22.8	8.4	31.4	1.1
Seattle, Wash	100.0	1.5	43.3	23.9	4.1	26.5	.7
Columbus, Ohio	100.0	2.0	29.9	29.3	2.5	35.3	.9
Rochester, N.Y	100.0	1.7	37.3	24.4	3.8	31.6	1.1
Cincinnati, Ohio-Ky	100.0	1.6	38.6	27.6	3.3	27.4	1.5
Buffalo, N.Y	100.0	1.5	37.2	24.1	3.5	31.8	2.0
Albany-Schenectady-Troy, N.Y	100.0	.8	28.0	24.8	2.2	43.3	1.0
Dallas, Tex	100.0	3.3	44.1	27.2	2.1	22.8	.6
Other locations	100.0	2.9	38.6	26.6	1.7	29.2	.9

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-6.—*Employed engineers, by region and State, 1960 census*

Region and State	Number	Percent
All regions	860, 949	100. 0
New England	61, 712	7. 2
Connecticut	19, 620	2. 3
Maine	2, 154	. 3
Massachusetts	33, 354	3. 9
New Hampshire	2, 307	. 3
Rhode Island	3, 026	. 4
Vermont	1, 251	. 1
Middle Atlantic	187, 949	21. 8
New Jersey	46, 675	5. 4
New York	87, 524	10. 2
Pennsylvania	53, 750	6. 2
East North Central	188, 344	21. 9
Illinois	52, 535	6. 1
Indiana	20, 476	2. 4
Michigan	43, 803	5. 1
Ohio	55, 301	6. 4
Wisconsin	16, 229	1. 9
West North Central	50, 931	5. 9
Iowa	6, 896	. 8
Kansas	9, 938	1. 2
Minnesota	12, 642	1. 5
Missouri	15, 873	1. 8
Nebraska	3, 597	. 4
North Dakota	943	. 1
South Dakota	1, 042	. 1
South Atlantic	92, 684	10. 8
Delaware	3, 746	. 4
District of Columbia	3, 162	. 4
Florida	16, 110	1. 9
Georgia	10, 831	1. 3
Maryland	22, 050	2. 6
North Carolina	8, 589	1. 0
South Carolina	4, 569	. 5
Virginia	18, 197	2. 1
West Virginia	5, 430	. 6
East South Central	31, 160	3. 6
Alabama	10, 829	1. 3
Kentucky	6, 820	. 8
Mississippi	3, 024	. 4
Tennessee	10, 487	1. 2
West South Central	60, 490	7. 0
Arkansas	2, 373	. 3
Louisiana	9, 022	1. 0
Oklahoma	9, 006	1. 0
Texas	40, 089	4. 7
Mountain	31, 815	3. 7
Arizona	5, 575	. 6
Colorado	9, 564	1. 1
Idaho	1, 732	. 2
Montana	1, 571	. 2
Nevada	1, 231	. 1
New Mexico	5, 451	. 6
Utah	5, 005	. 6
Wyoming	1, 686	. 2
Pacific	155, 864	18. 1
Alaska	1, 114	. 1
California	126, 092	14. 6
Hawaii	1, 992	. 2
Oregon	5, 817	. 7
Washington	20, 849	2. 4

NOTE: Percent detail may not add to totals because of rounding.

Source: U.S. Department of Commerce, Bureau of the Census, *United States Census of Population, 1960*, series PC(1)-D, *Detailed Characteristics*, for each State.

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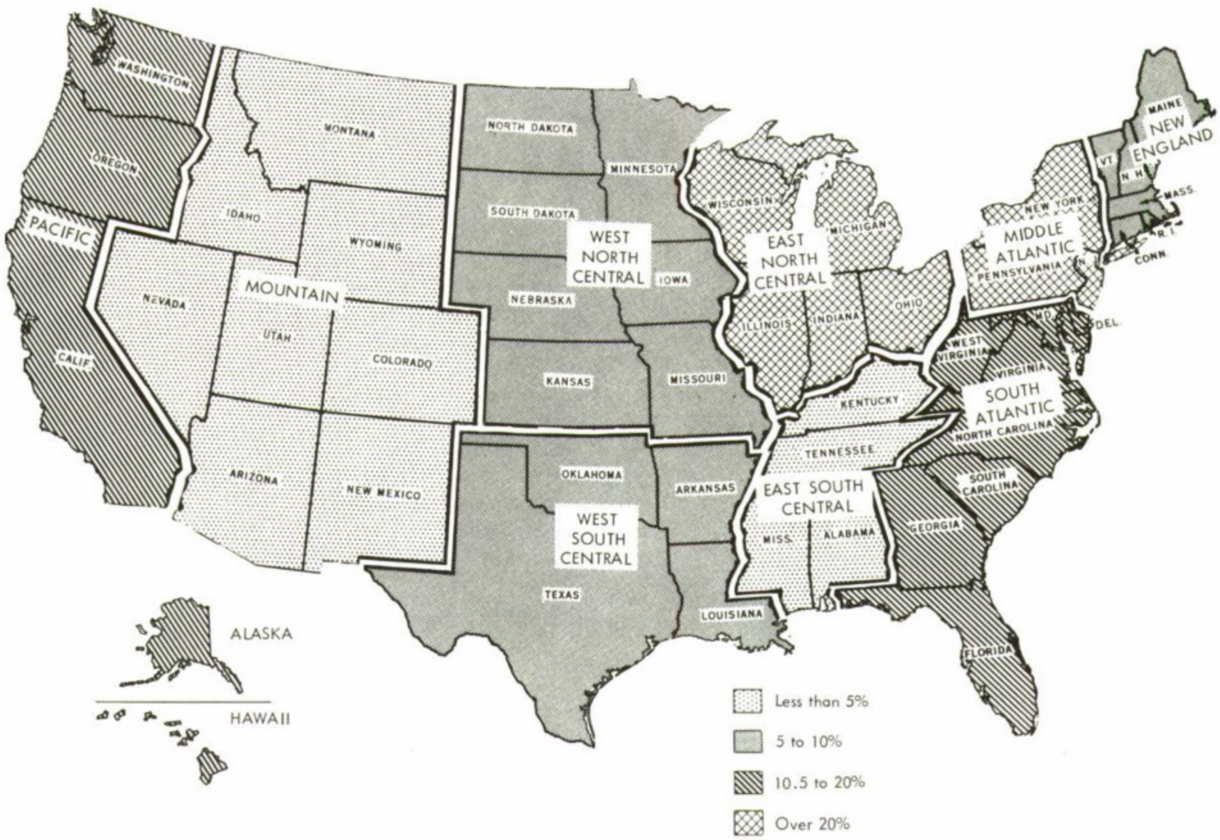
Chart IV–2. Engineers employed in the United States, by region, 1960



Source: Department of Commerce, Bureau of the Census.

TABLE IV–7.—*Employed male engineers, by field of engineering and geographic division, 1960 census*

Field	Number of engineers	Percent distribution by geographic division									
		Total	New England	Middle Atlantic	East North Central	West North Central	South Atlantic	East South Central	West South Central	Mountain	Pacific
All fields	853,738	100.0	7.2	21.8	21.9	5.9	10.8	3.6	7.0	3.7	18.1
Aeronautical	50,895	100.0	7.0	11.5	10.9	7.9	8.5	1.5	7.5	2.7	42.4
Chemical	40,637	100.0	4.9	26.0	19.6	4.7	13.2	4.9	13.3	2.6	10.8
Civil	154,293	100.0	6.2	18.3	16.7	7.6	12.5	5.8	8.6	5.3	19.0
Electrical	182,413	100.0	7.2	26.3	17.0	5.2	12.1	3.1	5.5	3.9	19.7
Industrial	95,389	100.0	8.5	22.7	27.2	6.1	11.0	3.9	4.9	2.5	13.2
Mechanical	157,660	100.0	7.7	20.9	30.0	5.2	8.7	3.0	5.2	2.8	16.5
Metallurgical and metallurgist	18,280	100.0	7.2	29.7	33.1	3.0	5.4	4.0	2.3	4.5	10.8
Mining	12,042	100.0	0.8	7.8	6.0	6.4	7.2	3.2	44.1	14.1	10.4
Sales	56,664	100.0	7.9	24.5	28.9	5.6	8.4	2.6	7.3	2.2	12.6
Other fields	85,465	100.0	7.8	21.9	23.5	5.6	11.9	3.0	5.6	3.9	16.8

NOTE.—Percent detail may not add to totals because of rounding.

Source: U.S. Department of Commerce, Bureau of the Census, *United States Census of Population, 1960*, series PC(1)–D, *Detailed Characteristics*, for each State.

TABLE IV-8.—*Employed male engineers, by selected Standard Metropolitan Statistical Area, 1960 census*

Area	Number	Percent
All locations	853, 738	100. 0
Selected SMSA's [1]	361, 214	42. 3
Los Angeles-Long Beach, Calif.	69, 068	8. 1
New York, N.Y.	48, 447	5. 7
Chicago, Ill.	39, 095	4. 6
Philadelphia, Pa.	28, 104	3. 3
Detroit, Mich.	27, 462	3. 2
Boston, Mass.	20, 150	2. 4
Washington, D.C.-Md.-Va.	19, 021	2. 2
San Francisco-Oakland, Calif.	17, 992	2. 1
Newark, N.J.	16, 520	1. 9
Pittsburgh, Pa.	14, 512	1. 7
Seattle, Wash.	14, 415	1. 7
Cleveland, Ohio	12, 984	1. 5
St. Louis, Mo.	11, 524	1. 4
Baltimore, Md.	11, 045	1. 3
Paterson-Clifton-Passaic, N.J.	10, 875	1. 3
Other locations	492, 524	57. 7

[1] Includes SMSA's with 10,000 or more engineers.

NOTE.—Percent detail does not add to selected SMSA's total because of rounding.

Source: U.S. Department of Commerce, Bureau of the Census, *United States Census of Population, 1960*, series PC(1)-C, *General Social and Economic Characteristics*, for each State.

astronomy had earned doctorates, and substantial numbers held master's degrees. Only in mathematics and statistics was the master's degree predominant (42 percent). As would be expected, professional medical degrees were significant only in the biological sciences (20 percent).

Although less than 3 percent of all scientific personnel in the National Register had less than a bachelor's degree, more than one-fourth of all personnel in meteorology did not hold a bachelor's degree. In all other fields (except the "other fields" category) less than 5 percent reported not holding at least a bachelor's degree.

In summary, the predominant degree for each field of specialization in 1962 was as follows:

Bachelor's	*Master's*
Agricultural sciences	Mathematics and statistics
Earth sciences	*Ph. D.*
Meteorology	Biological sciences
Chemistry	Psychology
Sanitary engineering	Physics and astronomy
"Other fields"	

Level of Education of Engineers

Information obtained on the educational background of persons classified as engineers in the 1960 census reveals only the number of years of

TABLE IV-9.—*Scientists in the National Register, by field and highest degree, 1962*

Scientific and technical field	Number of scientists	Percent distribution						
		Total	Less than bachelor's degree	Bachelor's	Master's	Professional medical	Ph. D.	No report
All fields	214, 940	100. 0	2. 7	36. 6	26. 4	2. 6	30. 8	1. 0
Agricultural sciences	12, 389	100. 0	1. 5	53. 4	25. 2	. 3	18. 8	. 8
Biological sciences	25, 554	100. 0	. 7	12. 1	18. 3	19. 8	48. 4	. 6
Psychology	16, 791	100. 0	. 1	4. 0	34. 0	. 3	61. 3	. 2
Earth sciences	18, 725	100. 0	2. 9	49. 8	29. 6	(1)	17. 2	. 5
Meteorology	5, 379	100. 0	27. 0	46. 5	18. 9	. 1	7. 0	. 6
Mathematics and statistics	18, 189	100. 0	2. 2	31. 5	41. 6	. 1	24. 4	. 2
Physics and astronomy	25, 725	100. 0	1. 5	31. 9	30. 9	. 1	35. 3	. 2
Chemistry	54, 130	100. 0	. 7	40. 2	20. 5	. 8	36. 1	1. 7
Sanitary engineering	4, 923	100. 0	3. 6	56. 1	33. 7	(1)	4. 6	2. 0
Other fields	33, 135	100. 0	6. 2	54. 0	25. 1	. 2	12. 7	1. 7

[1] Less than 0.05 percent.

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

formal schooling completed. Through a recently completed special survey of persons classified in scientific and technical occupations in the 1960 census, carried out by the Bureau of the Census for the National Science Foundation, information on the level of degree attained by these engineers was also obtained.

Of those engineers reporting their academic attainments, the greatest proportion (47 percent) held only the bachelor's degree, although an almost equal number held no college degree. This latter finding was in sharp contrast to the very small percentage of scientists in the National Register without a degree. Only a small proportion reported a graduate degree—slightly less than 1 percent at the Ph.D. level. (See table IV–10.) Although there has been increasing emphasis on graduate work for engineers during the past several years, the need for formal education beyond the bachelor's degree has not become the requirement for entry into the profession as much as for scientific occupations.

With the exception of those engineers classified as "professors and instructors," less than 10 percent of the personnel in all other engineering fields had an advanced degree. In contrast, half or more of the mechanical and industrial engineers reported no college degree at all.

Age Distribution

Scientists

The median age for all scientists in the National Register in 1962 was 38. Data reported to the Register in previous years have shown a similar age distribution, indicating an influx of younger people into most of the scientific fields covered (chart IV–3). The largest group (38 percent) reported ages in the thirties, and the group between ages 40–49 followed with 26 percent of the total. About 18 percent were under 30, compared with 5 percent who reported age 60 or over.

Mathematicians and physicists were the youngest scientists reported in the Register. About one-fourth or more of them reported ages under 30. (See table IV–11.) On the other hand, more than one-fifth of the personnel in sanitary engineering and the biological sciences were over 50.

Educational Level and Age. Data from the 1962 National Register indicate that high academic attainment was not necessarily associated with older scientific personnel. Although nearly 60 percent of all registrants held advanced degrees, almost half of those with the Ph.D. were under age 40, as were more than three-fifths of those with master's degrees. (See table IV–12.) The largest concentrations of personnel with master's and Ph.D. degrees were in their thirties, compared with the age group 35–44 for those with the professional medical degree (mostly M.D.'s but some D.D.S.'s and D.V.M.'s). The 25–34 age group contained the largest proportion of scientists with only the bachelor's degree, whereas nondegree personnel (requiring additional experience to qualify for inclusion in the Register) were more heavily concentrated in the ages 35–44.

TABLE IV–10.—*Percent distribution of engineers in the civilian labor force, by highest academic degree, 1960 census*

Engineers	Total [1]	No degree	Level of degree		
			Bachelor's [2]	Master's	Ph. D.
Total	100. 0	45. 5	47. 4	6. 2	0. 9
Professors and instructors [3]	100. 0	11. 1	25. 6	43. 3	21. 1
Civil	100. 0	47. 9	47. 3	4. 5	. 4
Electrical	100. 0	41. 6	50. 6	7. 1	. 6
Industrial	100. 0	55. 8	39. 1	4. 7	. 3
Mechanical	100. 0	50. 0	45. 3	4. 4	[4] . 3
Other	100. 0	41. 6	50. 2	6. 8	[4] 1. 3

[1] Covers approximately 869,000 persons.

[2] Includes associate degrees (1.4 percent total) and bachelor's with advanced work (17.3 percent total).

[3] Includes professors and instructors in all fields of engineering.

[4] Includes very small number with a professional medical degree.

NOTE.—Detail may not add to totals because of rounding.

Source: Estimates based on a postcensal survey of professional and technical manpower conducted for the National Science Foundation by the Bureau of the Census.

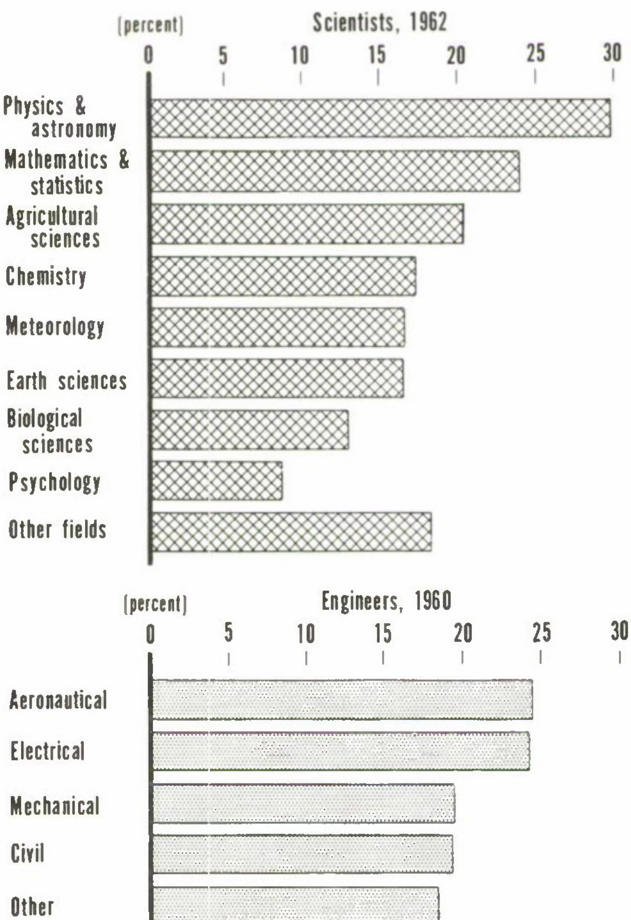
TABLE IV-11.—*Scientists in the National Register, by field and age group, 1962*

Scientific and technical field	Number of scientists	Percent distribution by age group												
		Total	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70 and over	No report
All fields	214,940	100.0	3.4	14.8	18.9	18.8	15.4	10.8	7.4	5.0	3.0	1.4	-------	0.2
Agricultural sciences	12,389	100.0	4.9	15.3	18.0	17.2	15.3	11.6	8.2	4.8	2.7	1.3	-------	.1
Biological sciences	25,554	100.0	2.4	9.6	17.1	19.8	15.9	12.3	9.1	6.3	4.0	2.1	1.3	.1
Psychology	16,791	100.0	.5	8.1	19.6	23.5	17.4	11.6	7.8	5.4	3.1	1.6	1.2	.4
Earth sciences	18,725	100.0	2.8	13.7	20.7	21.8	14.7	9.3	6.6	4.9	2.8	1.5	1.1	.1
Meteorology	5,379	100.0	3.4	13.2	19.2	15.7	24.4	13.2	5.9	3.0	1.1	.3	.2	.4
Mathematics and statistics	18,189	100.0	3.9	20.1	24.3	19.0	11.7	8.4	5.6	4.0	2.1	.7	.2	.1
Physics and astronomy	25,725	100.0	6.8	22.8	20.7	17.9	12.5	6.9	4.9	3.5	2.0	1.0	.7	.3
Chemistry	54,130	100.0	3.1	14.2	18.2	17.8	16.5	12.0	7.8	5.1	3.1	1.4	.7	.2
Sanitary engineering	4,923	100.0	2.4	13.2	13.9	16.5	13.0	11.5	10.9	9.0	5.1	2.4	1.7	.3
Other fields	33,135	100.0	3.2	15.1	17.0	17.8	15.8	11.4	8.0	5.5	3.4	1.5	1.0	.3

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Chart IV-3. Percent of scientists and engineers under 30 years of age, by field



Sources: National Science Foundation and Department of Commerce, Bureau of the Census.

Engineers

The median age for employed engineers as estimated from the 1960 Census of Population was 38.3—about the same as was estimated a decade earlier. About 20 percent of the engineers were under 30, compared with nearly 6 percent who were 60 or over. The largest proportion of engineers—34 percent of the total—was in the age group 25–34. (See table IV–13.)

In the fields of engineering for which age data were available, aeronautical and electrical engineers were the youngest groups. Almost one-fourth of these engineers were under the age of 30, and only about 4 percent of the aeronautical and 9 percent of the electrical engineers were reported as 55 or older. In comparison, about 18 percent of the civil engineers were 55 or over, and 19 percent were under 30 (chart IV–3).

Years of Professional Experience of Scientists

Variations in the number of years of professional experience reported by scientists in different fields partly reflect the rapid growth in some of the new scientific specializations compared with the older fields. Overall, more than half of the scientific and technical personnel in the National Register had 10 or more years of experience, and almost a fourth reported 20 or more years. Another one-fifth reported 5 to 9 years' experience, and nearly as many reported less than 5 years.

TABLE IV–12.—*Scientists in the National Register, by highest degree and age group, 1962*

Highest degree	Number of scientists	Percent distribution by age group												No report
		Total	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70 and over	
Total	214,940	100.0	3.4	14.8	18.9	18.8	15.4	10.8	7.4	5.0	3.0	1.4	0.8	0.2
Less than bachelor's	5,767	100.0	2.4	6.4	14.1	15.1	17.6	13.9	12.3	9.3	5.2	2.1	1.3	.4
Bachelor's	78,574	100.0	6.7	20.3	18.3	17.1	14.0	9.6	6.2	3.8	2.2	1.0	.6	.3
Master's	56,660	100.0	3.2	18.3	21.3	18.8	13.8	9.6	6.6	4.3	2.4	1.0	.5	.2
Professional medical	5,693	100.0	.1	5.5	15.0	21.1	18.6	13.8	10.3	6.6	4.7	2.8	1.3	.1
Ph. D	66,133	100.0	.1	7.1	18.8	21.2	17.9	12.5	8.5	6.4	4.0	2.0	1.3	.1
No report	2,113	100.0	1.6	4.4	8.9	11.9	15.0	14.0	16.9	12.3	8.2	3.5	3.0	.4

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV–13.—*Employed male engineers, by field and age group, 1960 census*

Engineering field	Number of engineers	Percent distribution by age group									Median age
		Total	Less than 24	25–29	30–34	35–44	45–54	55–59	60–64	65 and over	
All fields	853,738	100.0	5.6	14.7	19.2	32.2	17.0	5.7	3.6	2.1	38.3
Aeronautical	50,895	100.0	6.8	17.7	21.7	38.0	12.2	2.2	1.0	.4	36.0
Civil	154,293	100.0	6.2	13.0	17.3	25.9	19.8	8.2	5.3	4.2	40.2
Electrical	182,413	100.0	6.5	17.7	22.0	30.8	14.2	5.0	2.9	.9	36.2
Mechanical	157,660	100.0	5.4	13.9	17.8	33.5	17.2	5.9	4.1	2.1	38.8
Other fields	308,477	100.0	4.8	13.7	18.7	34.5	17.8	5.3	3.3	2.0	38.7

NOTE.—Percent detail may not add to totals because of rounding.
Source: U.S. Department of Commerce, Bureau of the Census, *United States Census of Population, 1960*, series PC(1)D, *Detailed Characteristics*, for each State.

Distributions by Field

Wide variations in years of experience were reported for the personnel in different scientific and technical fields. (See table IV–14.) Over 36 percent of those in the sanitary engineering field reported 20 or more years of experience, compared with 18 percent or less in the fields of physics and astronomy, mathematics and statistics, and psychology. Only in physics and astronomy did more than 25 percent of the personnel have less than 5 years of professional experience.

Educational Level and Experience

Although there is generally no direct correlation between the number of years of professional experience and the level of education attained by scientists, 37 percent of the scientists in the National Register with 20 or more years of experience in 1962 had attained the Ph.D. degree—a greater proportion than in any other experience group. On the other hand, 4 percent of those in the 15-to-19-years and the 20-years-or-more categories did not have bachelor's degrees, also more than reported in any other experience group. (See table IV–15.)

The highest proportion of master's degrees (35 percent) was reported by the group of scientists with 1 year of experience, and the proportions decreased with each succeeding group down to 22 percent for scientists with 20-or-more years' experience. Nearly a third or more of the scientists in each experience category reported a bachelor's as their highest degree. For personnel with a professional medical degree, the proportion of registrants holding this degree increased with their years of experience except for the 20-years-or-more group, which declined slightly.

Type of Employer of Scientists and Engineers

About 42 percent of the almost 215,000 persons

TABLE IV–14.—*Scientists in the National Register, by field and years of professional experience, 1962*

Scientific and technical field	Number of scientists	Percent distribution by years of professional experience							
		Total	1 year	2–4	5–9	10–14	15–19	20 or more	No report
All fields	214, 940	100. 0	2. 6	15. 0	20. 3	20. 7	10. 0	23. 5	7. 9
Agricultural sciences	12, 389	100. 0	4. 7	15. 7	18. 4	21. 4	9. 3	21. 3	9. 2
Biological sciences	25, 554	100. 0	2. 3	12. 3	20. 8	19. 7	10. 8	26. 2	8. 0
Psychology	16, 791	100. 0	1. 7	13. 6	25. 6	24. 5	9. 6	17. 9	7. 1
Earth sciences	18, 725	100. 0	3. 0	11. 6	17. 8	23. 9	8. 0	19. 1	16. 6
Meteorology	5, 379	100. 0	3. 1	13. 4	15. 9	19. 0	17. 6	21. 3	9. 7
Mathematics and statistics	18, 189	100. 0	2. 3	19. 1	28. 0	20. 7	8. 5	16. 4	5. 2
Physics and astronomy	25, 725	100. 0	4. 6	22. 7	22. 3	18. 9	8. 3	18. 1	5. 0
Chemistry	54, 130	100. 0	1. 8	14. 5	19. 1	20. 0	10. 9	28. 1	5. 6
Sanitary engineering	4, 923	100. 0	1. 8	11. 1	13. 1	19. 7	8. 8	36. 2	9. 2
Other fields	33, 135	100. 0	2. 0	13. 1	17. 2	20. 4	10. 6	26. 9	9. 9

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV–15.—*Scientists in the National Register, by years of professional experience and highest degree, 1962*

Years of professional experience	Number of scientists	Percent distribution						
		Total	Less than bachelor's degree	Bachelor's	Master's	Professional medical	Ph. D.	No report
Total	214, 940	100. 0	2. 7	36. 6	26. 3	2. 6	30. 8	1. 0
1 year or less	5, 508	100. 0	--------	46. 4	34. 8	1. 4	17. 2	. 2
2–4	32, 261	100. 0	. 6	47. 1	30. 7	1. 6	19. 8	. 2
5–9	43, 563	100. 0	1. 4	33. 6	28. 5	2. 5	33. 6	. 4
10–14	44, 454	100. 0	2. 3	35. 3	27. 0	2. 4	32. 3	. 7
15–19	21, 537	100. 0	4. 2	33. 1	23. 0	3. 8	34. 7	1. 2
20 or more	50, 608	100. 0	4. 0	31. 9	21. 8	3. 0	37. 3	2. 0
No report	17, 009	100. 0	5. 7	42. 7	26. 0	3. 5	20. 2	1. 9

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

responding to the National Register in 1962 were employed in industry or business or were self-employed—primarily the former.[6] The fields with the greatest proportions of scientists in industry were chemistry and the earth sciences. (See table IV–16.) The second largest employer was educational institutions—colleges, universities, and high schools—with 28 percent. More than one-third of all personnel in pysychology, mathematics, and statistics, and physics and astronomy, and considerably over half of those in the biological sciences, were employed in this sector.

Somewhat more than 17 percent of the scientists were government employees—about two-thirds of these were civilian employees of the Federal Government, and the other third worked for State, local, and international governmental organizations. More than half of the agricultural

[6] Although the number of scientists in the National Register was estimated to comprise somewhat over half of all scientists employed in the United States in 1962, the distribution of scientists, by employer, in the Register is believed to be fairly comparable to that for the total group. See ch. III for more comprehensive data on employment of engineering personnel.

TABLE IV–16.—*Scientists in the National Register, by field and type of employer, 1962*

Scientific and technical field	Number of scientists	Percent distribution by type of employer								
		Total	Educational institutions	Federal Government	Other government	Military and Public Health Service	Nonprofit organizations	Industry and business	Self-employed	Other and no report
All fields	214, 940	100. 0	28. 1	11. 6	5. 6	3. 0	4. 4	42. 2	2. 4	2. 7
Agricultural sciences	12, 389	100. 0	23. 4	36. 0	16. 9	1. 4	1. 0	17. 0	2. 6	1. 7
Biological sciences	25, 554	100. 0	55. 7	11. 0	6. 1	3. 2	6. 9	11. 4	2. 8	2. 9
Psychology	16, 791	100. 0	45. 6	9. 2	13. 7	1. 6	9. 7	10. 2	6. 7	3. 3
Earth sciences	18, 725	100. 0	18. 3	13. 4	4. 0	1. 9	1. 0	53. 6	2. 7	5. 1
Meteorology	5, 379	100. 0	8. 4	32. 3	1. 2	44. 3	2. 4	9. 8	. 3	1. 3
Mathematics and statistics	18, 189	100. 0	37. 5	9. 0	2. 7	1. 5	5. 7	40. 9	. 8	1. 9
Physics and astronomy	25, 725	100. 0	36. 2	11. 2	. 4	2. 4	8. 3	38. 3	. 9	2. 3
Chemistry	54, 130	100. 0	20. 7	6. 4	1. 7	. 8	3. 0	64. 0	1. 1	2. 3
Sanitary engineering	4, 923	100. 0	7. 4	6. 0	33. 4	7. 4	. 7	32. 9	8. 8	3. 4
Other fields	33, 135	100. 0	12. 1	10. 9	6. 3	2. 5	2. 3	60. 3	3. 0	2. 6

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

scientists and over one-third of the sanitary engineers and meteorologists were in government employment. Nonprofit institutions (i.e., private foundations, voluntary health agencies, etc.) employed more than 4 percent of the 1962 registrants, and 3 percent were serving with the Armed Forces or the Commissioned Corps of the U.S. Public Health Service.

Age and Type of Employer of Scientists

Information on the age distribution of scientists working for different types of employers shows that the largest proportions of scientists in industry and business, nonprofit organizations, and "other government" (State and local) were in their thirties. In the Federal Government and among the self-employed, those in the 35–44 age group were most numerous, compared with the 25–34 age group for scientific personnel in educational institutions. (See table IV–17.)

More than one-third of the scientists in the military services and Public Health Service and over one-fifth of those in educational institutions were in their twenties. However, while almost one-fifth of the scientists in educational institutions were over 50, this was true of only about 5 percent in the military services and the Public Health Service. The latter situation undoubtedly exists because of the earlier retirement provisions of the Armed Forces and because few scientists entered the military as a career 20 or more years ago.

Level of Education and Type of Employer of Scientists and Engineers

Reflecting the high levels of academic training required for employment by educational institutions, about 86 percent of all scientists in this area held advanced degrees and over half had attained their Ph.D. (See table IV–18.) Nonprofit organizations was the only other area in which nearly half of all scientists employed had the Ph. D. degree (chart IV–4).

Industry was the only sector in which half the employed scientists had only a bachelor's degree. About 15 percent of the scientists in the military services and U.S. Public Health Service reported less than the bachelor's degree; however, about 5 percent of the scientists in government agencies and 7 percent of the self-employed scientists also had less than a bachelor's degree.

Earlier employment surveys provide some pertinent data on the educational background of engineers in industry and State governments. In 1959, a survey of employment of scientific and technical personnel in industry showed that 78 percent of all engineers held a bachelor's or higher degree in some field. The proportion with degrees ranged from well over 9 out of 10 in the petroleum

TABLE IV-17.—*Scientists in the National Register, by type of employer and age group, 1962*

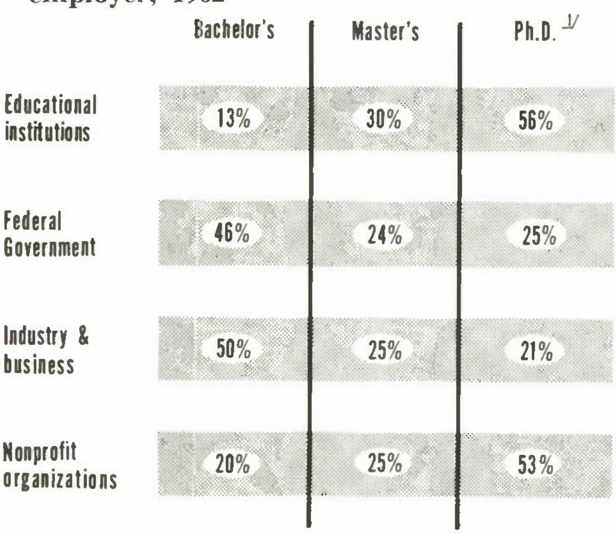
Type of employer	Number of scientists	Percent distribution by age group												
		Total	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70 and over	No report
All employers	214,940	100.0	3.4	14.8	18.9	18.8	15.4	10.8	7.4	5.0	3.0	1.4	0.9	0.2
Educational institutions	60,319	100.0	5.1	17.1	18.2	16.7	13.5	9.8	7.3	5.6	3.7	1.9	.9	.2
Federal Government	24,962	100.0	2.5	11.8	16.9	17.7	17.0	12.7	10.0	6.5	3.0	1.2	.5	.2
Other government	12,031	100.0	2.4	13.6	18.8	19.0	14.4	10.1	8.5	6.5	3.9	1.8	.8	.2
Military and U.S. Public Health Service	6,495	100.0	9.3	28.1	18.0	13.6	17.0	8.3	3.5	1.2	.4	(1)	(1)	.5
Nonprofit organizations	9,445	100.0	2.3	12.9	21.2	22.4	16.3	9.9	6.5	4.1	2.4	1.1	.7	.2
Industry and business	90,800	100.0	2.1	13.8	20.6	20.9	16.4	11.2	6.9	4.2	2.4	.8	.5	.2
Self-employed	5,095	100.0	.5	3.0	9.3	16.8	17.0	15.3	11.9	9.7	6.7	5.1	4.6	.1
Other employers and no report	5,793	100.0	9.4	21.1	15.2	13.1	10.0	6.3	4.5	4.7	4.5	5.2	5.7	.3

[1] Less than 0.05 percent.

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel. 1962.

Chart IV-4. Scientists holding bachelor's, master's, and Ph.D. degrees, by type of employer, 1962



[1] Includes those with a professional medical degree.

NOTE: Excludes those with less than a bachelor's degree and those not reporting.

Source: National Science Foundation.

and chemicals industries to about 7 out of 10 in the machinery and aircraft industries. (See table IV-19.) A survey of employment in State government agencies in 1959 revealed that only 59 percent of the engineers held a degree of any kind. In highway and public works departments, where civil engineers are by far the largest engineering group, only 56 percent had degrees, compared with almost 89 percent in health and welfare agencies. (See table IV-20.) The relatively low percentage of engineers with college degrees in State highway departments was further verified by a survey conducted by the Bureau of Public Roads. Almost 56 percent of the engineers were college graduates, and nearly one-tenth of these held degrees in fields other than engineering. (See table IV-21.)

In 1960, the Bureau of Labor Statistics conducted a survey for the National Science Foundation and the Mathematical Association of America to obtain information about persons employed in mathematical work in private industry, the Federal Government (including the Armed Forces), and nonprofit organizations. Information obtained from tne respondents in this survey showed a much higher proportion with advanced degrees in nonprofit organizations (56 percent) than in private industry (34 percent) or in Government (28 percent)—much the same situation that appeared for all scientists in both the 1960 and the 1962 National Register of Scientific and Technical Personnel. Substantial variations appeared from the overall industry distribution in the proportion of employees at each educational level for the various industries for which information was available. In the chemical industry, about half the employees had at least one advanced degree, including 17 percent with the Ph.D., compared with the insurance industry where less than 1 percent had obtained the Ph.D. The highest proportion of persons without a degree appeared in the machinery industry, although this industry also had one of the highest percentages of Ph.D.'s in mathematical work. (See table IV-22.)

Primary Function of Scientists

In addition to the employment information supplied by scientific personnel in the 1962

TABLE IV-18.—*Scientists in the National Register, by type of employer and highest degree, 1962*

Type of employer	Number of scientists	Percent distribution						
		Total	Less than bachelor's degree	Bachelor's	Master's	Professional medical	Ph. D.	No report
All employers	214, 940	100. 0	2. 7	36. 5	26. 4	2. 6	30. 8	1. 0
Educational institutions	60, 319	100. 0	. 3	13. 4	29. 7	4. 7	51. 7	. 2
Federal Government	24, 962	100. 0	4. 6	45. 6	23. 8	1. 3	23. 8	. 9
Other government	12, 031	100. 0	4. 8	39. 9	30. 9	3. 0	20. 0	1. 4
Military and Public Health Service	6, 495	100. 0	15. 1	42. 1	25. 4	6. 7	10. 3	. 4
Nonprofit organizations	9, 445	100. 0	1. 6	19. 8	25. 1	8. 0	44. 9	. 6
Industry and business	90, 800	100. 0	2. 5	50. 4	24. 5	. 3	20. 9	1. 4
Self-employed	5, 095	100. 0	6. 8	34. 4	19. 3	10. 3	26. 8	2. 4
Other employers and no report	5, 793	100. 0	3. 1	38. 1	31. 7	2. 9	23. 1	1. 1

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-19.—*Engineers holding a bachelor's or higher degree, by industry, January 1959*

Industry	Total engineers	Engineers with degrees	
		Number	Percent of total
All industries	615, 400	482, 300	78. 4
Food and kindred products	4, 100	3, 500	85. 1
Textile mill products and apparel	3, 700	3, 100	85. 6
Paper and allied products	6, 400	5, 300	82. 8
Chemicals and allied products	36, 600	34, 100	93. 1
Petroleum products and extraction	27, 900	26, 600	95. 3
Stone, clay, and glass products	7, 100	5, 400	76. 3
Primary metal industries	23, 300	19, 900	85. 3
Fabricated metal products and ordnance	31, 800	25, 100	79. 0
Machinery (except electrical)	62, 200	44, 000	70. 8
Electrical equipment	81, 300	70, 700	87. 0
Aircraft and parts	83, 100	59, 700	71. 8
Professional and scientific instruments	19, 000	13, 800	72. 4
Other manufacturing industries	47, 100	33, 900	72. 0
Construction	43, 000	31, 800	74. 0
Transportation and other public utilities	33, 700	28, 300	84. 1
Engineering and architectural services	53, 500	41, 400	77. 4
Other nonmanufacturing industries	51, 600	35, 500	68. 8

NOTE.—Percents computed from unrounded data.

Source: National Science Foundation, *Scientific and Technical Personnel in American Industry, Report on a 1959 Survey*, NSF 60-62.

TABLE IV-20.—*Engineers in State governments, by agency and percent with degrees and licenses, January 1959*

Agency	Total engineers	Percent with degrees	Percent with licenses [1]
All agencies	28, 172	58. 7	45. 3
Highway and public works	24, 887	56. 0	44. 1
Health and welfare	1, 212	88. 7	59. 8
Agriculture and conservation	724	76. 4	46. 8
Other agencies	1, 349	71. 3	52. 6

[1] Licensing is not required for most engineering positions in State government, and the qualifications required for a license vary widely among the States. Some require a degree or the equivalent plus engineering experience and a passing grade on an examination. Others grant licenses to applicants without examination or other requirements if they have had engineering experience.

Source: National Science Foundation, *Employment of Scientific and Technical Personnel in State Government Agencies—Report on a 1959 Survey*, NSF 61-17.

TABLE IV-21.—*Educational background of State highway department engineers, January 1960*

Educational background	Number	Percent
Total	23, 380	100. 0
College graduates	13, 030	55. 7
Civil engineer graduates	10, 400	44. 5
Other engineer graduates	1, 430	6. 1
Nonengineer graduates	1, 200	5. 1
No college degree	10, 350	44. 3

Source: James M. Montgomery and Elmer H. Rehberger, "Trends in Highway Engineering Employment: 1960 Inventory of State Highway Engineering Employment," In *Highway Employment Trends and Requirements*, Highway Research Board Bull. 296.

TABLE IV-22.—*Percent distribution of employees engaged in professional mathematical work, by type of employer and educational level, 1960*

Type of employer	Total [1]	Less than bachelor's	Bachelor's	Master's	Ph. D.
All employers (selected)	100.0	5.8	61.3	25.7	7.2
Private industry	100.0	4.7	61.4	26.5	7.4
Aircraft and parts	100.0	5.7	63.3	25.1	5.9
Transportation equipment (except aircraft)	100.0	2.4	62.5	28.4	6.7
Electrical machinery and supplies	100.0	4.9	58.9	27.5	8.7
Machinery, except electrical	100.0	5.8	55.5	26.9	11.8
Professional, scientific, and control instruments	100.0	1.6	58.0	29.6	10.8
Other durable manufacturing	100.0	5.6	58.6	31.0	4.8
Petroleum refining and extraction	100.0	1.6	58.9	27.1	12.4
Chemicals and allied products	100.0	3.2	47.1	32.6	17.1
Other nondurable manufacturing	100.0	4.1	53.8	31.4	10.7
Insurance	100.0	5.2	73.3	20.7	.8
Other nonmanufacturing	100.0	3.3	63.0	27.3	6.4
Federal Government	100.0	9.3	62.4	22.5	5.8
Nonprofit organizations	100.0	.9	43.3	35.3	20.5

[1] Covers approximately 9,800 employees of the industries, agencies, and organizations surveyed.

Source: National Science Foundation, *Employment in Professional Mathematical Work in Industry and Government*, NSF 62-12.

National Register, the primary function performed at the place of employment was reported. Nearly half of the scientific personnel in all sectors combined were in research, development, or design—35 percent in its performance and 13 percent concerned with the management and administration of research and development. With few exceptions, the largest proportions of scientific personnel in all fields were involved in this area. (See table IV-23.)

Almost 16 percent of all the scientists reported teaching as their main function, as did more than one-fourth of those in the biological sciences and mathematics and statistics. The category designated as production and inspection was reported by 9 percent. This area includes such activities as production, inspection, testing, quality control, sales, operations, and marketing. It was most important in chemistry and sanitary engineering.

The "other" functions category includes such activities as technical writing, field exploration, clinical and counseling practice, analysis, forecasting, and consulting. This group and those scientists who gave no report on their primary function made up 18 percent of the total. Over one-third of the scientists in psychology were reported in "other" functions because of their clinical activities and more than half of those in earth sciences and meteorology because of their field exploration activities.

Type of Employer and Primary Function

Over half of the scientists employed by educational institutions in 1962 were primarily engaged in teaching. Most of the others, 35 percent of the total, were conducting research, development, or design activities—26 percent in basic research and about 9 percent in applied research. Although many university and college scientists are engaged in both research and teaching, this distribution reports only the principal work activity in terms of actual time spent.

The largest group of Federal Government scientists (41 percent) were in research, development, or design. This was reported as follows: basic research, 20 percent; applied research, 19 percent; development or design, 2 percent. One-third of these Government scientists reported management or administration activities, with 21 percent of the total in research and development management or administration. By comparison, in the "other government" employer sector, the largest number (32 percent) were in management or administration, and 23 percent in performance of

TABLE IV-23.—*Scientists in the National Register, by field and primary function, 1962*

Scientific and technical field	Number of scientists	Percent distribution by primary function								
		Total	Research, development, or design			Management or administration		Teaching	Production and inspection	Other and no report
			Total [1]	Basic research	Applied research	Total [2]	Of R&D			
All fields	214,940	100.0	35.2	15.2	14.6	22.4	13.0	15.8	8.7	17.9
Agricultural sciences	12,389	100.0	26.5	8.6	17.3	49.8	29.2	8.2	2.6	12.9
Biological sciences	25,554	100.0	44.4	29.2	14.8	13.8	8.6	29.0	1.8	11.0
Psychology	16,791	100.0	26.6	8.1	17.6	15.4	5.9	22.0	.3	35.7
Earth sciences	18,725	100.0	14.3	8.3	5.9	13.6	6.5	12.6	5.1	54.4
Meteorology	5,379	100.0	18.0	8.5	9.2	20.1	6.5	3.9	1.1	56.9
Mathematics and statistics	18,189	100.0	32.5	7.9	16.5	20.0	11.1	29.1	8.7	9.7
Physics and astronomy	25,725	100.0	54.9	28.0	17.4	17.4	14.0	20.0	3.7	4.0
Chemistry	54,130	100.0	45.4	20.7	19.2	24.3	16.8	10.5	14.7	5.1
Sanitary engineering	4,923	100.0	16.5	1.7	3.9	28.9	6.3	5.0	15.0	34.6
Other fields	33,135	100.0	22.8	2.7	8.5	29.0	13.5	8.6	17.2	22.4

[1] Includes development or design, not shown separately.

[2] Includes management or administration of other than research and development, not shown separately.

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

research, development, or design (only 9 percent in basic research). (See table IV-24.)

Scientific personnel in the military services and Public Health Service reported the highest proportion (45 percent) in the "other" functions category, with many of these scientists involved in clinical practice and field studies. Another large group, 28 percent, were in management or administration; and 18 percent were in research and development work, with those in research about equally divided between basic and applied research.

TABLE IV-24.—*Scientists in the National Register, by type of employer and primary function, 1962*

Type of employer	Number of scientists	Percent distribution by primary function								
		Total	Research, development, or design			Management or administration		Teaching	Production and inspection	Other and no report
			Total [1]	Basic research	Applied research	Total [2]	Of R&D			
All employers	214,940	100.0	35.2	15.2	14.6	22.5	13.0	15.8	8.7	17.8
Educational institutions	60,319	100.0	35.0	26.1	8.5	6.3	2.9	52.8	.4	5.5
Federal Government	24,962	100.0	41.1	19.6	18.7	32.1	21.0	.9	5.6	20.3
Other government	12,031	100.0	22.7	8.7	11.9	31.7	12.5	7.0	8.0	30.6
Military and U.S. Public Health Service	6,495	100.0	18.2	8.4	8.4	27.8	10.8	4.3	4.8	44.9
Nonprofit organizations	9,445	100.0	54.5	28.6	21.8	21.3	14.7	1.7	3.2	19.3
Industry and business	90,800	100.0	36.7	7.6	18.5	30.2	18.2	.2	16.6	16.3
Self-employed	5,095	100.0	10.9	2.6	5.1	14.3	6.5	1.4	5.3	68.1
Other employers and no report	5,793	100.0	23.9	13.8	7.7	11.0	6.1	5.4	4.1	55.6

[1] Includes development or design, not shown separately.

[2] Includes management or administration of other than research and development, not shown separately.

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Basic research, the principal function of scientists employed by nonprofit organizations, occupied 29 percent of them, with another 22 percent performing applied research (chart IV-5). Management or administration was reported by 21 percent, with most of them concerned with research and development.

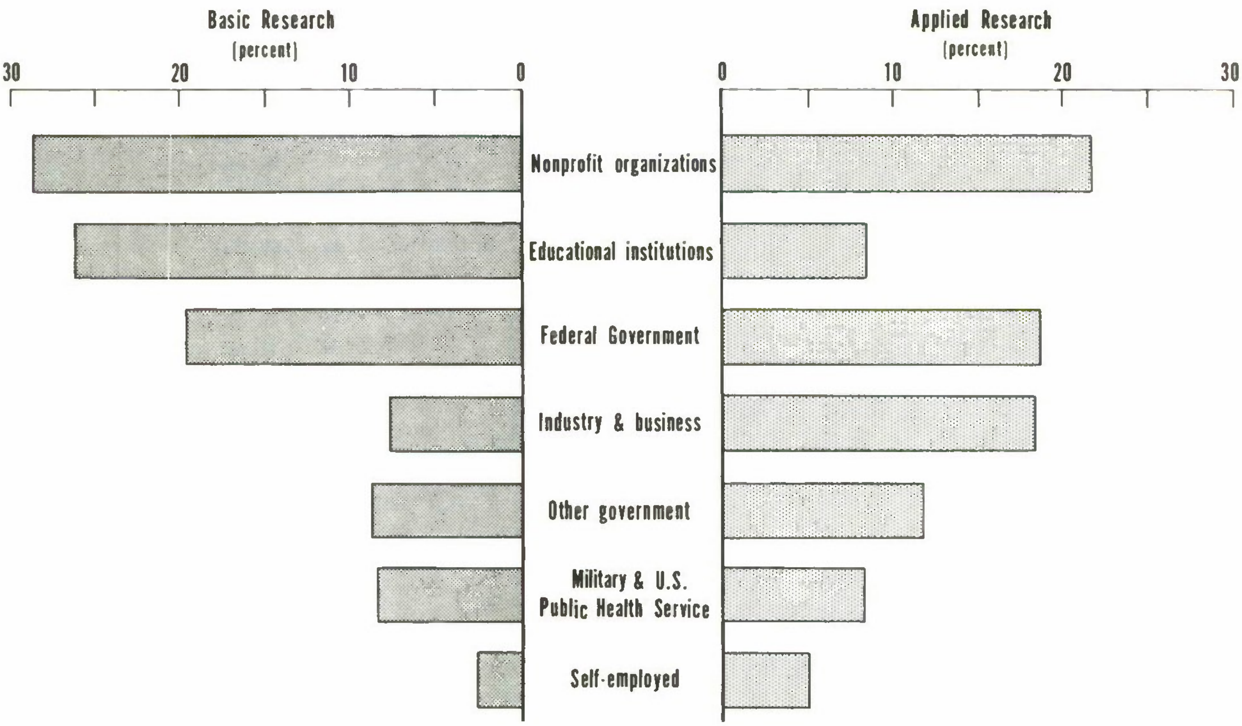
About 37 percent of the scientists employed in industry and business reported themselves principally involved in R&D activities. However, only about 8 percent were engaged in basic research. Another 17 percent were in production and inspection, the category which includes most manufacturing activities. About 30 percent of the private industry registrants were in management or administration, with 18 percent in management or administration of research and development.

Level of Education and Primary Function

Scientists with advanced degrees are frequently concerned with the fundamental aspects of scientific work. About 43 percent of the scientists in the National Register with the Ph.D. degree were primarily concerned with research, development, or design; and of these, about three-fifths were engaged in basic research. (See table IV-25.) Moreover, scientists with the Ph.D. made up 54 percent of all scientists in basic research. Although management or administration of research and development was reported as the primary function of 15 percent of the Ph.D.'s, compared with somewhat lower proportions with bachelor's and master's degrees in this function, scientific personnel with only the bachelor's degree made up the largest percentage of all personnel in R&D management, 37 percent. Almost 27 percent of all Ph.D.'s were primarily engaged in teaching, and of all scientific personnel in this activity more than half had obtained the Ph.D. degree.

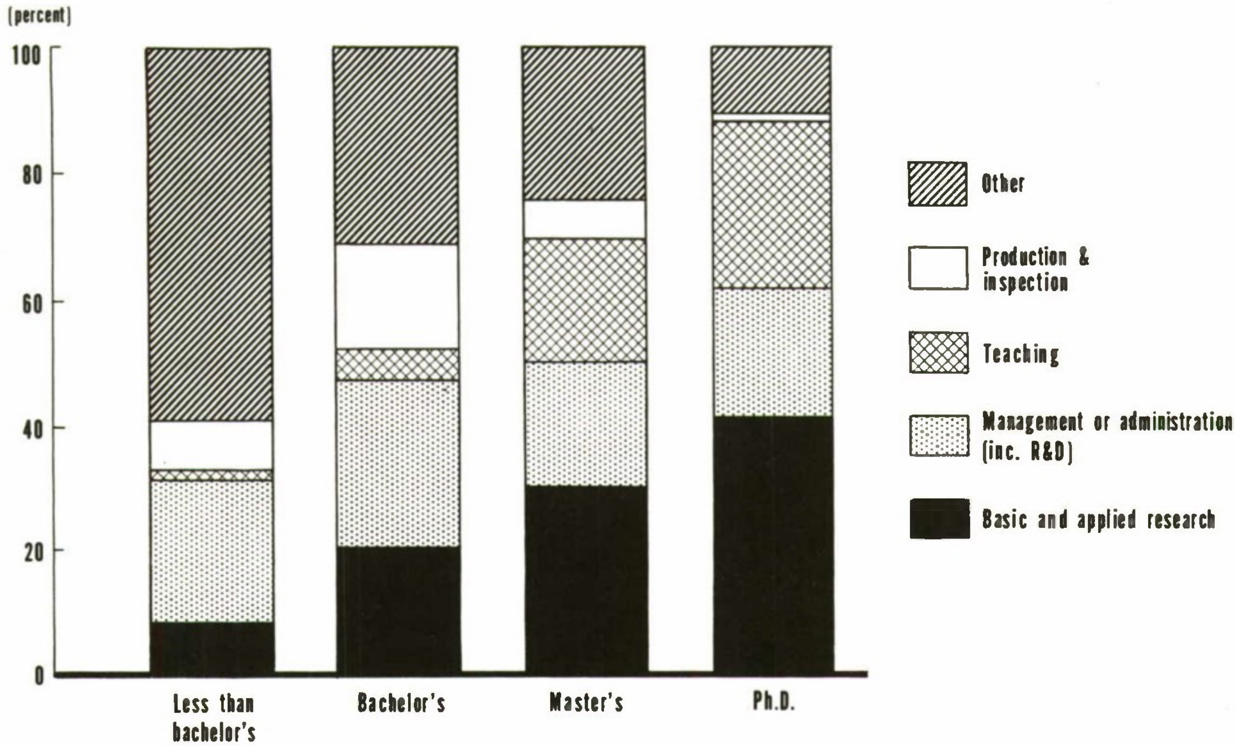
Scientists with master's degrees were involved more in applied than basic research—18 and 13 percent, respectively—while 19 percent were in teaching, and 20 percent were engaged in management or administration (chart IV-6). Seventy-one percent of all scientists in production activities reported the bachelor's degree. Of the scientific

Chart IV-5. Scientists engaged in basic and applied research, by type of employer, 1962



Source: National Science Foundation.

Chart IV-6. Functions of scientists, by level of academic degree, 1962



Source: National Science Foundation.

personnel with less than a bachelor's degree, over half were in the "other functions" category.

Years of Experience and Primary Function

Of the 35 percent of all National Register scientists in research, development, or design, more than half reported less than 10 years of professional experience and over one-fourth had 10 to 19 years' experience. About 30 percent of the scientific personnel in basic research had less than 5 years' experience, considerably more than for the same experience group in applied research as well as for any other function. (See table IV-26.)

The most experienced of all scientific personnel were those in management and administration, particularly R&D management and administration. In the latter group, 40 percent reported 20 years or more experience.

Among the scientists in teaching, 40 percent had less than 10 years of professional experience, 28 percent had 10 to 19 years, and 27 percent had 20 or more years. The experience distribution for personnel in production and inspection differed primarily in the somewhat smaller proportion with 20 or more years of experience.

Age and Primary Function

Both experience and age data reveal that the highest proportions of younger scientists in the National Register were primarily engaged in R&D activities, particularly basic research. About 25 percent of the total personnel in research and development were in the 20-29 age group, and 43 percent reported 30-39. (See table IV-27.) Only 10 percent reported 50 years of age or over. Basic research scientists averaged somewhat younger than those in applied research. Nearly 30 percent of the basic research group was under age 30, compared with only about 20 percent of those in applied research in this age group.

In the teaching category, 51 percent of the personnel were under 40, and 24 percent were 50 or over. Those scientists primarily concerned with management or administration reported more than 26 percent age 50 or over, but only about 37 percent reported less than age 40, and

TABLE IV-25.—*Scientists in the National Register, by primary function and highest degree, 1962*

Function	Number of scientists	Percent distribution						
		Total	Less than bachelor's degree	Bachelor's	Master's	Professional medical	Ph. D.	No report
All functions	214, 940	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0
Research, development, or design	75, 679	35. 2	12. 6	29. 4	36. 0	44. 6	42. 9	25. 8
Basic research	32, 744	15. 2	2. 8	7. 9	12. 6	23. 9	26. 8	7. 1
Applied research	31, 282	14. 6	5. 4	12. 6	17. 6	20. 6	14. 8	12. 9
Management or administration	48, 226	22. 4	23. 4	26. 6	19. 9	12. 6	20. 2	29. 0
Management or administration of R&D	28, 752	13. 0	8. 6	13. 2	11. 1	7. 9	15. 0	15. 0
Teaching	33, 907	15. 8	1. 3	5. 1	19. 4	19. 2	26. 8	3. 0
Production and inspection	18, 778	8. 7	7. 4	17. 0	6. 6	. 4	1. 2	18. 3
Other functions	34, 471	16. 0	52. 5	19. 5	16. 0	22. 5	8. 1	21. 7
No report	3, 879	1. 8	2. 9	2. 4	2. 1	. 7	. 8	2. 2
All functions	214, 940	100. 0	2. 7	36. 6	26. 4	2. 6	30. 7	1. 0
Research, development, or design	75, 679	100. 0	1. 0	30. 5	26. 9	3. 4	37. 5	. 7
Basic research	32, 744	100. 0	. 5	19. 0	21. 8	4. 1	54. 1	. 5
Applied research	31, 282	100. 0	1. 0	31. 5	31. 7	3. 7	31. 2	. 9
Management or administration	48, 226	100. 0	2. 8	43. 3	23. 4	1. 5	27. 7	1. 3
Management or administration of R&D	28, 752	100. 0	1. 8	37. 2	22. 7	1. 6	35. 7	1. 1
Teaching	33, 907	100. 0	. 2	11. 8	32. 4	3. 2	52. 2	. 2
Production and inspection	18, 778	100. 0	2. 3	71. 3	20. 0	. 1	4. 3	2. 0
Other functions	34, 471	100. 0	8. 8	44. 4	26. 3	3. 7	15. 6	1. 3
No report	3, 879	100. 0	4. 3	49. 0	31. 0	1. 0	13. 5	1. 2

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-26.—*Scientists in the National Register, by years of professional experience, and percent distribution in each function, 1962*

Years of professional experience	Number of scientists	Percent in each function									
		Total	Research, development, or design			Management or administration		Teaching	Production and inspection	Other	No report
			Total [1]	Basic research	Applied research	Total [2]	Of R&D				
Total	214, 940	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0
1 year or less	5, 508	2. 6	3. 3	4. 9	2. 2	. 9	. 8	3. 0	1. 9	2. 7	7. 1
2–4	32, 261	15. 0	21. 4	25. 0	17. 3	4. 7	4. 0	15. 9	18. 2	12. 6	16. 9
5–9	43, 563	20. 3	26. 0	25. 5	25. 9	11. 9	11. 8	20. 8	21. 1	19. 2	12. 8
10–14	44, 454	20. 7	20. 4	17. 4	23. 1	22. 5	23. 3	17. 9	21. 9	22. 3	7. 2
15–19	21, 537	10. 0	8. 4	7. 3	9. 5	13. 8	14. 3	9. 9	9. 1	9. 9	2. 4
20 or more	50, 608	23. 5	14. 7	13. 0	16. 9	38. 7	39. 7	26. 5	20. 6	21. 1	17. 7
No report	17, 009	7. 9	5. 8	7. 1	5. 2	7. 5	6. 1	6. 0	7. 3	12. 2	36. 0

[1] Includes persons in development and design, not shown separately.

[2] Includes management or administration of other than research and development, not shown separately.

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE VI-27.—*Scientists in the National Register, by primary function and age group, 1962*

Function	Number of scientists	Percent distribution by age group												
		Total	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70 and over	No report
All functions	214,940	100.0	3.4	14.8	18.9	18.8	15.4	10.8	7.4	5.0	3.0	1.4	0.8	0.2
Research, development, or design	75,679	100.0	4.5	20.8	24.0	19.3	13.6	7.5	4.4	2.7	1.6	.8	.5	.2
Basic research	32,744	100.0	5.7	23.9	24.2	18.3	12.3	6.5	3.7	2.4	1.5	.9	.6	.2
Applied research	31,282	100.0	3.2	16.3	23.5	20.8	15.3	8.9	5.4	3.2	1.8	.9	.5	.2
Management or administration	48,226	100.0	.9	5.1	11.4	19.2	20.4	16.9	12.0	7.7	4.2	1.4	.6	.2
Management or administration of research and development	28,752	100.0	.8	4.5	11.3	19.9	21.2	16.9	11.6	7.5	4.0	1.5	.7	.2
Teaching	33,907	100.0	3.5	12.7	17.4	17.3	14.1	11.0	8.6	7.0	4.6	2.4	1.1	.2
Production and inspection	18,778	100.0	3.7	19.5	20.8	18.4	13.9	9.8	6.4	3.9	2.3	.7	.4	.3
Other functions	34,471	100.0	2.8	13.3	19.4	19.9	15.3	10.2	7.4	5.3	3.2	1.7	1.3	.2
No report	3,879	100.0	15.6	25.6	14.4	9.9	6.5	4.3	3.4	3.7	4.2	5.4	6.8	.3

NOTE.—Percent detail may not add to totals because of rounding.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

6 percent were in their 20's. There was no significant difference for those in management or administration of research and development.

Scientific personnel in production and inspection activities were a younger group than those in management and administration or teaching. About 23 percent in production and inspection were less than 30 years old, while 14 percent were 50 or over.

Foreign Language Proficiency of Scientists

Almost three-fourths of the scientists who reported to the National Register of Scientific and Technical Personnel in 1962 indicated that they had some knowledge of a foreign language (reading, writing, or speaking). (See table IV–28.) German and French were the two most frequently cited, by 48 percent and 39 percent, respectively, as the language of either first or second proficiency. Spanish was the only other language in which more than 10 percent reported some proficiency. Russian and Italian were reported by 6 and 3 percent of the scientists, respectively.

Almost two-thirds or more of the scientists in the National Register in every scientific and technical field except agricultural sciences and sanitary engineering reported knowledge of at least one foreign language. Over 80 percent of the scientific personnel in biology, chemistry, and physics and astronomy reported such knowledge. (See table IV–29.)

Professional Income and Salaries of Scientists and Engineers

Information on earnings of scientists and engineers is available primarily from surveys of the individual scientists and engineers themselves and from employers. This report draws upon surveys and studies conducted by both governmental and nongovernmental sources, including the National Science Foundation's National Register of Scientific and Technical Personnel, the U.S. Department of Labor's Bureau of Labor Statistics, the Engineers Joint Council, the National Society of Professional Engineers, the U.S. Civil Service Commission, and the Los Alamos Scientific Laboratory of the University of California. Although the data from these surveys sometimes overlap in terms of personnel covered, a sufficient amount of unique detail warrants presenting the information from all of these sources.

Earnings of Scientists

The National Register of Scientific and Technical Personnel for 1962 contains data on the basic annual median salaries associated with the principal professional employment of full-time employed registrants.[7] The 1962 salaries ranged from a high of $11,000 median for physics and astronomy to a low of $8,000 for the agricultural sciences and meteorology. Median salaries for personnel in the biological and earth sciences, mathematics and statistics, chemistry, and sanitary engineering were at the $10,000 level—equal to the median

[7] Detailed data from the 1964 National Register on salaries will be available in a National Science Foundation report, *Reviews of Data on Science Resources* 1:2, December 1964. In press.

TABLE IV-28.—*Foreign language knowledge reported by scientists in the National Register, by first and second proficiency, 1962*

Foreign language	Number	Percent
Total scientists	214, 940	100. 0
First language		
Total reporting at least 1 language	157, 895	73. 5
German	66, 297	30. 7
French	38, 182	17. 8
Spanish	22, 701	10. 6
Russian	9, 248	4. 3
Italian	3, 570	1. 7
Japanese	1, 943	. 9
Polish	1, 672	. 8
Hebrew	1, 344	. 6
Chinese	1, 119	. 5
Swedish	1, 042	. 5
Greek	1, 024	. 5
Dutch	782	. 4
Portuguese	677	. 3
Other foreign language	8, 294	3. 9
No report	57, 045	26. 5
Second language		
Total reporting second language	106, 955	49. 8
German	37, 948	17. 7
French	44, 702	20. 8
Spanish	13, 788	6. 4
Russian	2, 615	1. 2
Italian	2, 157	1. 0
Japanese	413	. 2
Polish	448	. 2
Hebrew	494	. 2
Chinese	159	. 1
Swedish	381	. 2
Greek	233	. 1
Dutch	346	. 2
Portuguese	456	. 2
Other foreign language	2, 815	1. 3
No report	107, 985	50. 2

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

for all fields. (See table IV-30.) The overall median annual salary reported for 1962 represented a $1,000 increase over that reported for 1960. Because a number of fields reported in 1960 were combined in 1962, the two sets of data are not strictly comparable in several fields. (See table IV-31.)

TABLE IV-29.—*Scientists in the National Register reporting language knowledge, by field, 1962*

Scientific and technical field	Total	Number reporting language	Percent reporting language
All fields	214, 940	157, 895	73. 5
Agricultural sciences	12, 389	5, 766	46. 5
Biological sciences	25, 554	21, 199	83. 0
Psychology	16, 791	12, 886	76. 7
Earth sciences	18, 725	13, 414	71. 6
Meteorology	5, 379	3, 437	63. 9
Mathematics and statistics	18, 189	14, 129	77. 7
Physics and astronomy	25, 725	21, 571	83. 9
Chemistry	54, 130	43, 986	81. 3
Sanitary engineering	4, 923	2, 206	44. 8
Other specialties	33, 135	19, 301	58. 2

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Educational Background and Earnings. In 1962, the median annual salary for all Ph. D. scientists in the National Register was $11,000, and in every field was $10,000 or higher. (See table IV-32.) Overall, scientists with the bachelor's and master's degrees were paid about the same salaries; but in three fields (psychology, earth sciences, and mathematics and statistics) master's degree holders received somewhat less. The main reason the master's degree holders appeared to earn no more in some fields than those with the bachelor's degree was that they probably were less experienced than those with less formal education (chart IV-7).

In most fields, scientists with less than a bachelor's degree who reported to the National Register indicated salaries equal to or higher than those with the bachelor's or master's. This is primarily because nondegree personnel require more experience than those with degrees in order to qualify for registration in the National Register.

Age and Earnings. The median annual salary for the youngest National Register scientists, ages 20-24, was $6,000 in 1962. Successively higher medians of about $1,000 were reported for each 5-year age group until age 45-49, where a peak median salary of $12,000 was attained. Scientists 70 and over were still earning a $10,000 median salary in 1962. (See table IV-33.) Among the individual scientific and technical fields, scientists in most fields appear to have reached their peak median salaries in the age group 45-49.

TABLE IV-30.—*Salary distribution of scientists in the National Register, by field, 1962*

Scientific and technical field	Lower decile	Lower quartile	Median	Upper quartile	Upper decile
All field	$6, 000	$8, 000	$10, 000	$13, 000	$16, 000
Agricultural sciences	5, 000	7, 000	8, 000	10, 000	12, 000
Biological sciences	6, 000	8, 000	10, 000	13, 000	17, 000
Psychology	6, 000	8, 000	9, 000	11, 000	15, 000
Earth sciences	7, 000	8, 000	10, 000	12, 000	16, 000
Meteorology	4, 000	6, 000	8, 000	10, 000	12, 000
Mathematics and statistics	6, 000	8, 000	10, 000	13, 000	17, 000
Physics and astronomy	7, 000	8, 000	11, 000	14, 000	18, 000
Chemistry	7, 000	8, 000	10, 000	13, 000	16, 000
Sanitary engineering	7, 000	8, 000	10, 000	12, 000	15, 000
Other fields	7, 000	8, 000	10, 000	13, 000	17, 000

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

NOTE: Estimates of 1964 National Register median salaries for selected fields show the following: agricultural sciences, $9,200; biological sciences, $10,700; psychology, $10,300; earth sciences, $10,300; meteorology, $10,600; mathematics, $11,000; physics, $12,000; chemistry, $11,000.

TABLE IV-31.—*Median annual salaries of scientists in the National Register, by field, 1960 and 1962*

Scientific and technical field	1960 median	1962 median
All fields	$9, 000	$10, 000
Agricultural sciences	7, 000	8, 000
Biological sciences	8, 000	10, 000
Medical sciences	12, 000	
Psychology	8, 000	9, 000
Earth sciences	9, 000	10, 000
Geography	8, 000	
Meteorology	8, 000	8, 000
Mathematics and statistics [1]	9, 000	10, 000
Physics	10, 000	11, 000
Astronomy	9, 000	
Chemistry	10, 000	10, 000
Sanitary engineering	9, 000	10, 000
Chemical engineering	11, 000	10, 000
Other engineering	10, 000	
Other fields	10, 000	

[1] Statistics not included for 1960.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1960 and 1962.

Professional Experience and Earnings. The salary pattern of National Register scientists in relation to years of experience is similar to that for age distribution. Scientists with 1 year or less of experience received a median salary of about $6,000 in 1962, while those with 20 years or more received twice that amount.

Although there was a spread of only $2,000 between the lowest and highest median salaries ($6,000 to $8,000) in the different scientific and technical fields for scientists with 2 to 4 years of professional experience, the spread widens considerably with more experience. By the time 15 or more years of experience had been obtained, the range of median annual salaries covered a spread of $5,000—from a low of $9,000 for agricultural scientists and meteorologists to a high of $14,000 for those in physics and astronomy. After 20 or more years of experience, however, the salary differentials among the various fields became somewhat smaller. (See table IV-34.)

Type of Employer and Earnings. Self-employed scientists reporting to the National Register in 1962 generally reported the highest median salaries ($13,000), followed by those in industry and nonprofit organizations with $11,000. (See table IV-35.) Salaries of Federal Government scientists and those employed by educational institutions were about $1,000 higher than median salaries of those employed by other government agencies (State, local, and international). Scientists on active duty with the Armed Forces and in the U.S. Public Health Service reported the lowest median annual salaries, $7,000. However, such personnel received allowances for subsistence, quarters, etc., which were not included in the basic salary rate reported.

The general salary pattern for scientists varied considerably among fields by type of employer. Nonprofit organizations appeared to pay more than any other employer to those in the agricultural sciences, meteorology, sanitary engineering, and the "other fields" category. Scientists

TABLE IV-32.—*Median annual salaries of scientists in the National Register, by field and highest degree, 1962*

Scientific and technical field	Total	Less than bachelor's degree	Bachelor's	Master's	Professional medical	Ph. D.
All fields	$10,000	$9,000	$9,000	$9,000	$14,000	$11,000
Agricultural sciences	8,000	7,000	7,000	8,000	10,000	10,000
Biological sciences	10,000	7,000	7,000	7,000	14,000	10,000
Psychology	9,000	----------	9,000	8,000	13,000	10,000
Earth sciences	10,000	10,000	10,000	9,000	----------	10,000
Meteorology	8,000	6,000	8,000	9,000	----------	12,000
Mathematics and statistics	10,000	10,000	10,000	9,000	----------	11,000
Physics and astronomy	11,000	10,000	9,000	10,000	----------	13,000
Chemistry	10,000	10,000	9,000	10,000	12,000	12,000
Sanitary engineering	10,000	10,000	10,000	10,000	----------	11,000
Other fields	10,000	9,000	10,000	11,000	15,000	13,000

NOTE.—No median salary computed for groups with fewer than 25 registrants.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-33.—*Median annual salaries of scientists in the National Register, by field and age group, 1962*

Scientific and technical field	Total	Age groups (years)										
		20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70 and over
All fields	$10,000	$6,000	$7,000	$9,000	$10,000	$11,000	$12,000	$12,000	$12,000	$12,000	$12,000	$10,000
Agricultural sciences	8,000	5,000	6,000	7,000	8,000	9,000	10,000	10,000	11,000	11,000	11,000	----------
Biological sciences	10,000	5,000	6,000	8,000	9,000	11,000	12,000	12,000	12,000	12,000	12,000	11,000
Psychology	9,000	6,000	7,000	8,000	9,000	10,000	10,000	10,000	10,000	10,000	10,000	9,000
Earth sciences	10,000	5,000	7,000	8,000	10,000	11,000	12,000	12,000	12,000	13,000	12,000	12,000
Meteorology	8,000	4,000	5,000	7,000	8,000	9,000	9,000	10,000	10,000	10,000	----------	----------
Mathematics and statistics	10,000	7,000	8,000	10,000	11,000	12,000	12,000	12,000	11,000	11,000	9,000	9,000
Physics and astronomy	11,000	7,000	8,000	10,000	12,000	13,000	14,000	13,000	13,000	12,000	11,000	8,000
Chemistry	10,000	6,000	7,000	9,000	10,000	12,000	12,000	12,000	12,000	12,000	12,000	11,000
Sanitary engineering	10,000	6,000	7,000	8,000	10,000	10,000	12,000	12,000	12,000	12,000	12,000	12,000
Other fields	10,000	7,000	8,000	9,000	11,000	12,000	13,000	13,000	13,000	13,000	12,000	10,000

NOTE.—No median salary computed for groups with fewer than 25 registrants.

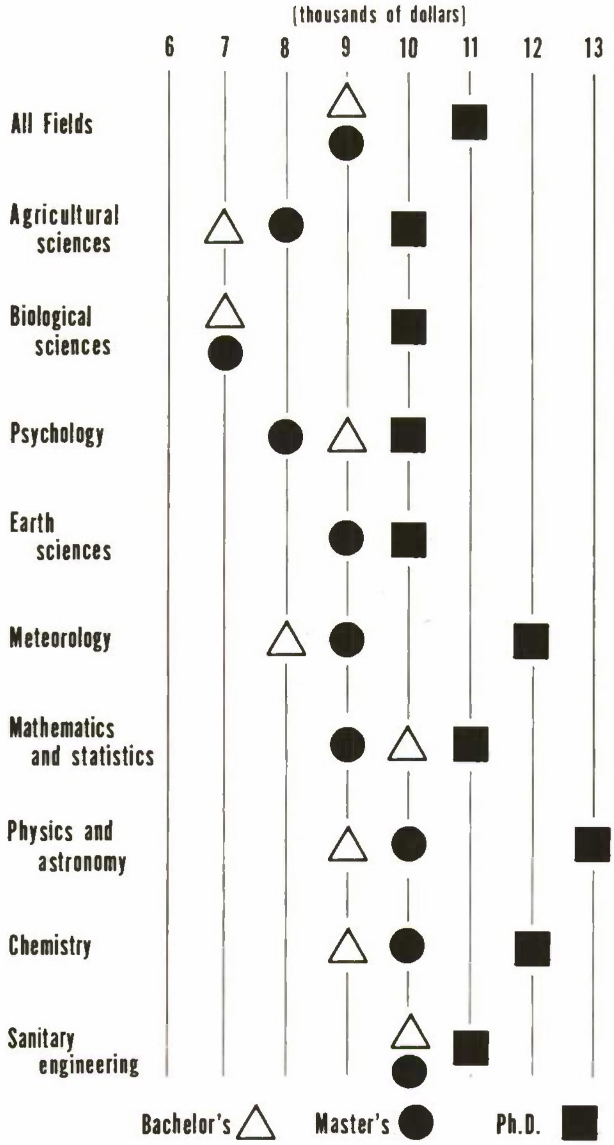
Source National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-34.—*Median annual salaries of scientists in the National Register, by field and years of professional experience, 1962.*

Scientific and technical field	Total	Years of professional experience					
		1	2 to 4	5 to 9	10 to 14	15 to 19	20 or more
All fields	$10,000	$6,000	$7,000	$9,000	$10,000	$11,000	$12,000
Agricultural sciences	8,000	5,000	6,000	7,000	8,000	9,000	11,000
Biological sciences	10,000	6,000	7,000	8,000	10,000	11,000	12,000
Psychology	9,000	7,000	7,000	9,000	10,000	10,000	11,000
Earth sciences	10,000	6,000	7,000	8,000	10,000	12,000	13,000
Meteorology	8,000	5,000	6,000	8,000	8,000	9,000	10,000
Mathematics and statistics	10,000	7,000	7,000	10,000	12,000	12,000	12,000
Physics and astronomy	11,000	7,000	8,000	10,000	12,000	14,000	14,000
Chemistry	10,000	7,000	7,000	9,000	10,000	12,000	13,000
Sanitary engineering	10,000	6,000	7,000	8,000	10,000	11,000	12,000
Other fields	10,000	7,000	7,000	9,000	11,000	12,000	13,000

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Chart IV–7. Median annual salaries of scientists, by field and highest degree, 1962



Source: National Science Foundation.

in the agricultural sciences, earth sciences, mathematics and statistics, and sanitary engineering employed by the Federal Government reported median salaries equal to those in private industry in the same fields.

Primary Function and Earnings. Scientists primarily engaged in management or administration were the highest paid group in 1962 with a median annual salary of $13,000—considerably more than the average $10,000 for scientists in all functions combined. The salary rate for those concerned with the management and administration of research and development in physics and astronomy, $16,000, was the highest of all fields. (See table IV–36.)

The median salary for scientists engaged in research, development, or design activities was $10,000—the same as for all functions. The type of research did not appear to have much influence on salary except in mathematics and statistics and in sanitary engineering, where scientists in applied research reported higher salaries than did those in basic research.

Teaching was the lowest paying function for most scientists, although in some fields teachers' salaries were comparable with other nonmanagement functions. The general exception was agricultural sciences, where teaching personnel reported a median salary of $9,000—higher than any of the other functions performed by agricultural scientists. Another factor affecting the salary levels of teachers was their academic rank. (See table IV–37.) The median salary for full professors was $12,000, compared with $9,000 for associate professors and $6,000 for instructors. In addition, many professors and associate professors in most fields receive supplemental income from other sources, such as research, writing, and consulting.

Earnings of Personnel Employed in Mathematical Work

In a 1960 survey of employment of persons engaged in mathematical work, information was obtained on the annual incomes of such personnel.[8] Based on responses from approximately 10,000 persons (86 percent men and 14 percent women), median income was estimated to be $8,500 in 1960; the median income for women ($6,600) was about 25 percent lower than for men ($8,900). (See table IV–38.)

[8] National Science Foundation, *Employment in Professional Mathematical Work in Industry and Government*, NSF 62–12. Persons included in this survey covered not only individuals with the title of mathematician but also persons with titles such as computer programer, operations research analyst, mathematical statistician, actuary, research engineer, and engineering analyst if they were professional personnel engaged in primarily mathematical work.

TABLE IV-35.—*Median annual salaries of scientists in the National Register, by field and type of employer, 1962*

Scientific and technical field	Total	Educational institutions	Federal Government	Other government	Military and Public Health Service	Nonprofit organizations	Industry and business	Self-employed	Other employer
All fields	$10,000	$9,000	$9,000	$8,000	$7,000	$11,000	$11,000	$13,000	$10,000
Agricultural sciences	8,000	9,000	8,000	7,000	--------	9,000	8,000	9,000	9,000
Biological sciences	10,000	9,000	10,000	9,000	9,000	11,000	11,000	18,000	10,000
Psychology	9,000	9,000	10,000	8,000	8,000	9,000	12,000	15,000	9,000
Earth sciences	10,000	8,000	10,000	8,000	6,000	10,000	10,000	12,000	10,000
Meteorology	8,000	9,000	9,000	9,000	6,000	11,000	10,000	--------	--------
Mathematics and statistics	10,000	8,000	11,000	9,000	7,000	12,000	11,000	18,000	11,000
Physics and astronomy	11,000	8,000	10,000	10,000	6,000	13,000	12,000	15,000	11,000
Chemistry	10,000	8,000	10,000	9,000	7,000	10,000	11,000	15,000	10,000
Sanitary engineering	10,000	9,000	10,000	9,000	7,000	12,000	10,000	13,000	11,000
Other fields	10,000	9,000	10,000	9,000	6,000	12,000	11,000	12,000	12,000

NOTE.—No median salary computed for groups with fewer than 25 registrants.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

TABLE IV-36.—*Median annual salaries of scientists in the National Register, by field and primary function, 1962*

Scientific and technical field	Total	Research, development, or design			Management or administration		Teaching	Production and inspection	Other
		Total [1]	Basic research	Applied research	Total [2]	Of R&D			
All fields	$10,000	$10,000	$10,000	$10,000	$13,000	$13,000	$8,000	$9,000	$9,000
Agricultural sciences	8,000	8,000	8,000	8,000	8,000	8,000	9,000	7,000	7,000
Biological sciences	10,000	10,000	10,000	10,000	13,000	14,000	8,000	8,000	10,000
Psychology	9,000	9,000	9,000	9,000	12,000	13,000	8,000	9,000	9,000
Earth sciences	10,000	9,000	9,000	9,000	13,000	13,000	8,000	9,000	10,000
Meteorology	8,000	10,000	10,000	10,000	10,000	12,000	9,000	8,000	7,000
Mathematics and statistics	10,000	10,000	10,000	11,000	14,000	14,000	8,000	9,000	11,000
Physics and astronomy	11,000	11,000	11,000	11,000	15,000	16,000	8,000	9,000	10,000
Chemistry	10,000	10,000	10,000	10,000	14,000	14,000	8,000	9,000	10,000
Sanitary engineering	10,000	9,000	8,000	9,000	11,000	12,000	9,000	9,000	10,000
Other fields	10,000	10,000	10,000	10,000	13,000	14,000	8,000	10,000	9,000

[1] Includes development or design, not shown separately.

[2] Includes management or administration of other than research and development, not shown separately.

NOTE.—No median salary computed for groups with fewer than 25 registrants.

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Both men and women with advanced degrees received considerably higher incomes than did those with less education—60 percent more for men with the Ph.D. than with the bachelor's degree, and almost 70 percent more for the women. This was also true in almost all age groups, although the difference narrowed for men past age 40. However, incomes for women at all educational levels and in all age groups were consistently lower than for men. The gap between earnings for men and women widened considerably with increases in age and experience.

Persons in mathematical work received much higher incomes in the insurance industry than in other segments of private industry, the Federal Government, or nonprofit organizations. However, the highest average income ($14,200) was reported by employees of nonprofit organizations with a Ph. D. degree.

TABLE IV-37.—*Median annual salaries of scientists in the National Register in teaching, by academic rank, 1962*

Academic rank	Median salaries
Total	$9,000
Dean	14,000
Professor	12,000
Associate professor	9,000
Assistant professor	8,000
Instructor	6,000
Lecturer	8,000
Research associate	8,000
Research assistant	6,000

Source: National Science Foundation, National Register of Scientific and Technical Personnel, 1962.

Employees in the insurance industry without a college degree, most of whom were engaged in actuarial work and were associates or fellows of a professional actuarial society, had higher median incomes than did those with the bachelor's and master's degrees. (See table IV-39.) Median incomes for personnel performing mathematical work were higher in private industry than in the Government at all degree levels, but lower for those without degrees.

The earnings of persons at all degree levels and in all employment sectors surveyed increased with age and experience, although the increments rose much more rapidly in industry than in the Government. Generally, the peak earnings of Government employees in mathematical work with bachelor's or master's degrees were reached during their late 40's, while employees in private industry continued to increase their income up through the age group 55–59. Earnings of mathematics employees increased much more rapidly in the insurance industry than in the other segments of private industry and the Government. After the age of 35, the disparity in income between insurance industry employees and employees in the other sectors continued to widen markedly, particularly in the older age groups. (See table IV-40.)

Earnings of Engineers

Data from a survey of the Engineers Joint Council, Engineering Manpower Commission on the earnings of engineers with college degrees (estimated to cover about 25 percent of all employed engineers) show overall 1964 median earnings of $10,475. Trend data based on previous

TABLE IV-38.—*Median annual income of persons in mathematical employment in industry and the Federal Government, by educational level, sex, and age, 1960* [1]

Educational level	All age groups [2]	Under 25	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64
All levels	$8,500	$6,100	$7,300	$9,100	$10,300	$10,500	$10,900	$11,000	$11,600	$11,200
Men	8,900	6,400	7,400	9,200	10,500	10,900	11,400	12,200	12,300	11,400
Women	6,600	5,700	6,600	7,100	7,300	7,600	7,800	7,600	8,400	--------
No degree	7,900	5,500	6,700	7,700	7,900	8,900	8,900	10,000	[3] 9,100	[3] 9,100
Men	8,000	5,700	6,700	7,700	8,100	9,100	9,300	10,100	[3] 9,600	[3] 9,600
Women	6,400	--------	--------	--------	--------	--------	--------	--------	--------	--------
Bachelor's degree	7,700	6,100	7,000	8,500	9,300	9,700	10,200	10,800	13,100	11,600
Men	8,100	6,300	7,100	8,700	9,700	10,200	11,000	12,500	14,200	12,500
Women	6,500	5,700	6,500	6,900	7,100	7,300	7,500	7,100	--------	--------
Master's degree	9,900	7,300	8,300	9,900	11,100	11,400	11,500	11,200	10,500	--------
Men	10,100	7,400	8,300	10,000	11,200	11,700	11,800	12,300	11,300	--------
Women	8,000	--------	7,600	7,900	7,800	[4] 8,900	[4] 8,900	[5] 8,700	[5] 8,700	--------
Ph. D. degree	13,000	--------	10,800	12,100	13,700	14,300	14,200	13,800	[6] 13,100	[6] 13,100
Men	13,100	--------	10,800	12,200	13,800	14,600	14,400	14,100	[6] 13,200	[6] 13,200
Women	11,000	--------	--------	--------	--------	--------	--------	--------	--------	--------

[1] No median income computed for groups with fewer than 20 persons.
[2] Total for all age groups includes respondents who did not specify age and those 65 or over for whom no data are shown because fewer than 20 provided information.
[3] Median based on the combined 5-year age groups, 55–59 and 60–64, as fewer than 20 persons were in each group.
[4] Median based on the combined 5-year age groups, 40–44 and 45–49, as fewer than 20 persons were in each group.
[5] Median based on the combined 5-year age groups, 50–54 and 55–59, as fewer than 20 persons were in each group.
[6] Median based on the combined 5-year age groups, 55–59 and 60–64, as fewer than 20 persons were in each group.

Source: National Science Foundation, *Employment in Professional Mathematical Work in Industry and Government*, NSF 62-12.

TABLE IV-39.—*Median annual income of persons in mathematical employment, by principal type of employer and educational level, 1960*

Type of employer	Total [1]	Less than bachelor's	Bachelor's	Master's	Ph. D.
All employers (selected)	$8,500	$7,900	$7,700	$9,900	$13,000
Private industry	8,800	7,800	7,900	10,100	13,300
Insurance industry	10,900	13,500	10,000	13,000	([2])
Private industry excluding insurance	8,700	7,600	7,700	10,000	13,300
Federal Government	7,900	7,900	7,300	9,100	11,800
Nonprofit organizations	9,400	([2])	6,900	9,600	14,200

[1] Covers approximately 9,300 employees of the industries, agencies, and organizations surveyed.

[2] No median income computed for groups with fewer than 20 persons.

Source: National Science Foundation, *Employment in Professional Mathematical Work in Industry and Government*, NSF 62-12.

TABLE IV-40.—*Median annual income of persons employed in mathematical work, by age, educational level, and type of employer, 1960* [1]

Age group	No degree			Bachelor's degree			Master's degree			Ph. D. degree		
	Private industry, excluding insurance	Insurance	Government	Private industry, excluding insurance	Insurance	Government	Private industry, excluding insurance	Insurance	Government	Private industry, excluding insurance	Insurance	Government
All age groups	$7,600	$13,500	$7,900	$7,700	$10,000	$7,300	$10,000	$13,000	$9,100	$13,300	----------	$11,800
Under 25 years	6,000	----------	----------	6,300	5,900	5,600	7,500	----------	----------	----------	----------	----------
25–29 years	6,700	----------	----------	7,200	7,100	6,500	8,500	----------	7,100	10,900	----------	----------
30–34 years	7,700	----------	7,600	8,700	10,000	7,900	10,000	10,300	8,900	12,600	----------	10,600
35–39 years	7,800	----------	8,000	9,600	12,300	8,400	11,300	13,100	10,100	14,100	----------	12,000
40–44 years	10,400	----------	8,300	9,900	16,600	8,400	12,000	15,500	10,100	14,800	----------	[2] 12,500
45–49 years	----------	----------	8,200	10,100	18,500	8,900	12,000	18,000	10,500	15,200	----------	
50–54 years	----------	----------	[2] 8,600	10,900	[3] 20,000+	8,100	12,500	----------	9,600	[2] 15,300	----------	12,600
55–59 years				12,000	17,900	7,700	----------	----------	----------		----------	----------
60–64 years	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------

[1] No median income computed for groups with fewer than 20 persons.

[2] Medians computed for 10-year age groups with 20 or more persons where there were fewer than 20 in each of two adjacent 5-year age groups.

[3] Respondents were not asked to report their precise income but to check the appropriate income class. For this group, the median fell in the open-end class of $20,000 and over.

Source: National Science Foundation, *Employment in Professional Mathematical Work in Industry and Government*, NSF 62-12.

surveys indicate that between 1953 and 1964, the total increase in median salaries was about 62 percent. However, although the median salaries have continued to rise, the rate of percent increase appears to have declined in the last several years. (See table IV-41.)

In engineering colleges, basic teaching salaries were lower than salaries for engineers in industry and government. However, total professional earnings of engineering teachers were higher than earnings of engineers in government, although not quite as high as those in industry. Teachers in technical institutes reported earnings generally lower than those of any other group.

TABLE IV-41.—*Trend in the median annual salaries of engineering graduates, selected years, 1953–1964*

Year	Median salary [1]	Percent increase over previous median salary
1964	$10,475	2
1962	10,025	2
1960	9,650	5
1958	8,800	5
1956	7,975	8
1953	6,450	----------

[1] Salaries adjusted each year to compensate for differences in median years of experience in order to have a comparable series.

Source: Engineers Joint Council, Engineering Manpower Commission, *Professional Income of Engineers, 1964*.

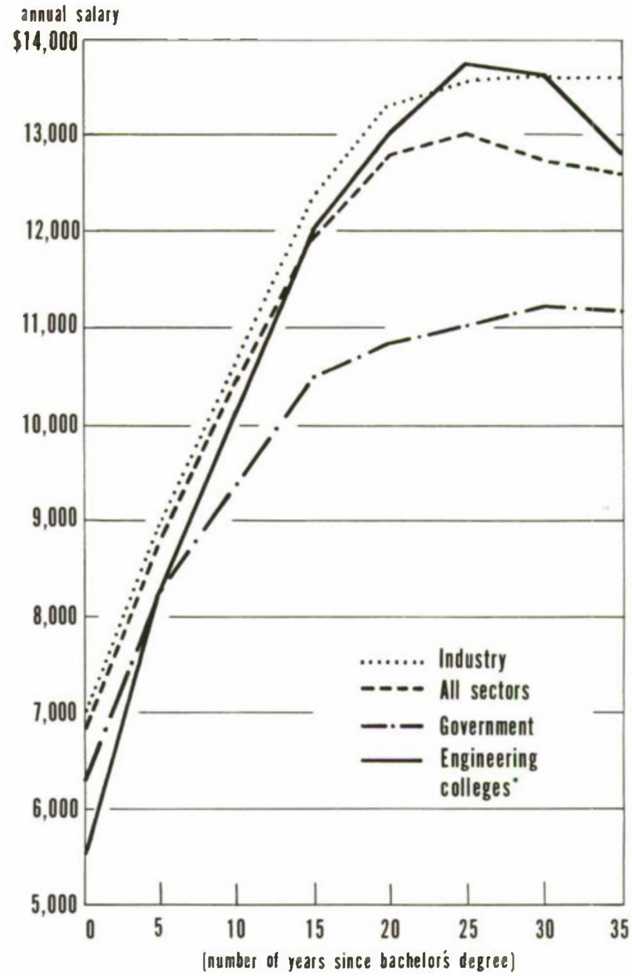
Professional Experience and Earnings. In 1962,[9] the range in median earnings for engineers was from $6,750 for those with less than 1 year of experience to $12,925 for those who had received their undergraduate degree 21 to 25 years ago. Generally, after 25 years of experience, earnings tended to taper off, although varying for engineers working for different types of employers. In industry as a whole, where the range was $6,925 for those with less than 1 year of experience to $13,775 for those with 36 years or more experience, peak median earnings occurred at the 26–30-year level, tapered off slightly at 31–35 years, and thereafter rose again (chart IV–8). Of the industries employing the largest numbers of engineers (11,000 or more), the chemical, petroleum, and utilities industries were the only ones where median earnings showed a steady increase through all successive years of experience. For engineers in most industries, after 25 years since the attainment of the baccalaureate, earning patterns appear to fluctuate. The highest median earnings reported were in the primary metal (ferrous) and petroleum industries—$20,000 and $16,300, respectively—for engineers 36 years or more after the baccalaureate. (See table IV–42.)

In the government sector, median earnings were lower than in industry, ranging from $6,225 for beginners to $10,825 for engineers with 36 years or more experience. In the Federal Government, median salaries increased as years of experience increased up until the 36-year level. In local government, salaries decreased after 30 years of experience but rose again for those with 36 years or more experience. Engineers employed in State highway commissions (most engineers in State governments work in this type of agency) had the lowest salaries at all levels of experience.

Educational Background and Earnings. Earnings of engineers, by level of degree held in 1962, are also available from the Engineering Manpower Commission's 1962 report. As table IV–43 indicates, earnings tend to increase with the attainment of an advanced degree. Over 40 percent of the Ph.D. engineers earned more than $15,000, compared with about 20 percent of the engineers with the master's degree and 11 percent with the bachelor's degree. Among the engineers with the bachelor's degree, who comprised well over 80 percent of the total, nearly half earned between $6,000 and $10,000, while slightly more than the same proportion of Ph. D.'s earned from $10,000 to $15,000.

Field of Engineering and Earnings. A 1962 salary survey conducted by the National Society of Professional Engineers of its membership[10]

Chart IV–8. Median annual earnings of engineering graduates in industry, government, and engineering colleges, 1962



*Total professional income shown.

Source: Engineers Joint Council, Engineering Manpower Commission.

[9] The 1964 Engineers Joint Council report, *Professional Income of Engineers, 1964*, was received too late to include detailed salary data by years of professional experience, type of employer, and level of degree.

[10] See National Society of Professional Engineers, *Professional Engineers Income and Salary Survey, 1962.* Membership in the NSPE is restricted to engineers who are registered under the engineering registration laws of the individual States.

TABLE IV-42.—*Median earnings of engineering graduates, by type of employer and number of years since baccalaureate degree, 1962*

Type of employer	Number of engineers covered	Median earnings of engineers by number of years since baccalaureate degree								
		Less than 1	5	10	14-16	17-20	21-25	26-30	31-35	36 or more
Total	213,584	$6,750	$8,725	$10,425	$11,900	$12,550	$12,925	$12,725	$12,575	$12,425
Industry	165,066	6,925	8,900	10,625	12,300	13,050	13,650	13,675	13,650	13,775
Aerospace (missiles, aircraft and parts)	22,411	7,275	9,525	11,575	13,450	13,950	14,075	13,625	13,575	11,850
Chemical	16,055	6,850	8,525	10,175	12,225	13,375	14,400	15,150	15,525	15,725
Communications (telephone, telegraph, radio, and television broadcasting)	8,438	6,275	8,075	9,700	11,900	12,125	12,600	11,975	12,475	13,225
Construction	3,636	6,700	8,350	9,925	11,375	12,625	12,700	13,300	12,750	12,800
Consulting services	4,215	6,300	7,925	9,450	11,175	11,475	12,350	12,575	12,775	13,300
Electrical machinery and electronics	50,760	7,175	9,025	10,975	12,875	13,575	14,225	14,350	15,175	14,900
Fabricated metal products	2,020	6,775	8,025	9,200	10,825	12,375	12,850	13,175	13,125	13,350
Instrument manufacturing	6,041	6,975	9,800	12,050	13,775	14,825	14,600	13,550	14,250	12,050
Machinery manufacturing (except electrical)	5,189	6,775	8,125	9,400	10,650	11,275	12,000	12,400	12,700	13,100
Mining-smelting (nonferrous)	1,113	6,475	7,850	8,850	9,400	9,925	11,600	11,700	12,000	11,875
Motor vehicles	1,482	6,875	8,775	10,650	(1)	(1)	(1)	(1)	(1)	(1)
Petroleum	14,507	6,725	8,150	9,900	12,025	12,850	13,975	15,025	15,425	16,300
Primary metal (ferrous)	705	6,850	8,675	9,825	11,625	12,550	12,875	14,900	14,950	20,000
Railroads industries	1,262	6,350	7,700	8,900	10,500	10,725	10,700	11,350	10,925	11,125
Research and development activities	11,667	7,100	9,800	11,850	13,575	14,475	14,825	14,550	15,550	16,075
Stone, clay, and glass products	1,279	6,850	8,550	10,100	11,250	11,200	11,425	11,775	12,000	12,800
Utilities (electric and gas)	11,025	6,750	8,175	9,675	10,825	11,050	11,475	11,500	12,575	13,000
Food products	655	6,725	7,825	9,300	9,850	10,675	11,425	10,550	11,150	11,125
Paper products	960	6,950	9,000	10,400	11,825	12,575	12,100	13,000	12,750	15,500
Miscellaneous (n.e.c.)	1,646	6,500	8,150	9,775	11,450	11,850	12,575	13,575	12,900	12,900
All government levels	41,339	6,225	8,250	9,325	10,425	10,725	10,925	11,075	11,150	10,825
Federal Government (civilians only)	29,056	6,150	8,375	9,750	10,575	10,875	11,050	11,200	11,275	10,900
State government	9,911	6,500	7,750	9,175	9,950	9,475	9,875	10,275	10,675	10,350
Local government	2,372	6,650	7,775	8,700	10,075	10,300	10,450	10,625	10,375	11,650
Engineering colleges: Basic teaching salaries	6,897	5,050	6,625	8,000	9,250	10,100	10,600	10,975	10,725	10,600
Total professional income		5,425	8,225	10,125	12,000	12,800	13,450	14,000	13,000	12,450
Technical institutes: Basic teaching salaries	200	5,750	7,000	6,375	8,000	6,750	7,200	7,375	7,250	6,500
Total professional income		5,750	8,750	6,375	9,250	7,250	8,325	8,875	8,375	7,250
Engineering societies	82	(1)	8,250	11,750	12,500	11,000	14,000	12,000	15,500	15,800

[1] Insufficient data.

NOTE.—Earnings represent salaries, including cost-of-living allowances and bonuses, but not payment for overtime work. For educational institutions, both basic teaching salaries and total professional incomes are shown.

Source: Engineers Joint Council, Engineering Manpower Commission, *Professional Income of Engineers, 1962.*

TABLE IV-43.—*Annual earnings of engineers, by level of degree held, 1962*

(In percent)

Level of degree	Total	Less than $5,000	$5,000 to $5,999	$6,000 to $7,999	$8,000 to $9,999	$10,000 to $14,999	$15,000 to $19,999	$20,000 to $24,999	$25,000 and over
Total degrees	100.0	0.2	0.8	17.5	26.5	41.8	9.9	2.0	1.3
Bachelor's	100.0	.2	.9	19.7	28.1	40.2	8.2	1.6	1.1
Master's	100.0	.1	.5	17.3	21.5	49.8	16.5	3.0	1.3
Ph. D	100.0	(1)	(1)	1.3	6.6	49.7	28.9	9.0	4.4

[1] Less than 0.05 percent.

NOTE.—Detail may not add to totals because of rounding.

Source: Engineers Joint Council, Engineering Manpower Commission, *Professional Income of Engineers, 1962.*

covered only a very small proportion, about 3 percent, of the estimated number of engineers employed in the United States. Although the survey data may not be representative of the engineering profession, it provides some earnings information related to a number of factors not available from other sources. Median earnings, by branch of engineering, were $11,000 or more for all except agricultural engineers. Chemical engineers had the highest median, $12,850; and

aeronautical, mining and metallurgical, and "other" engineers also earned more than $12,000. (See table IV–44.)

Type of Employer and Earnings. In 1962, median earnings for all engineers except those in State or local government agencies exceeded $10,000 annually. The highest earnings were in construction contractor firms, consulting firms, and the "other" category, which undoubtedly reflected the large proportions of self-employed in these fields. This is further substantiated by the finding that the median income for all the self-employed (somewhat over 15 percent of all engineers in the NSPE survey) was $16,920, compared with $10,920 for salaried personnel. (See table IV–45.)

Type of Work and Earnings. In addition to the factors of employment field and employment status, the type of work performed by engineers also appears directly related to the amount of earnings. The highest median earnings ($14,320) were obtained, as might be expected, by engineers in executive-administrative work, followed by those in consulting ($12,990). Those engaged in construction supervision had the lowest median earnings ($9,910). (See table IV–46.)

TABLE IV–44.—*Median earnings of engineers, by field of engineering, 1962*

Field of engineering	Median earnings
Aeronautical	$12, 100
Agricultural	8, 830
Chemical	12, 830
Civil	10, 680
Electrical	11, 990
Industrial	11, 880
Mechanical	11, 660
Mining and metallurgical	12, 330
Petroleum	11, 620
Sanitary	11, 340
Other, unclassified	12, 600

Source: National Society of Professional Engineers, *Income and Salary Survey, 1962.*

Engineering Teachers and Earnings. The 1962 median salaries and incomes of engineering teachers are available from a separate report of the Engineering Manpower Commission.[11] Median

TABLE IV–45.—*Median earnings of engineers, by type of employer and employment status, 1962*

Type of employer and employment status	Median earnings
Type of employer:	
Industry	$11, 960
Public utilities	11, 380
Federal Government	10, 850
State government	9, 350
County or municipal government	9, 970
Education	11, 960
Consulting firms	12, 280
Construction contractor	13, 450
Other	12, 280
Employment status:	
Self-employed	16, 920
Employee	10, 920

Source: National Society of Professional Engineers, *Income and Salary Survey, 1962.*

TABLE IV–46.—*Median earnings of engineers, by type of work performed, 1962*

Type of work	Median earnings
Executive—administrative	$14, 320
Sales	12, 160
Teaching	11, 180
Design	9, 940
Production and maintenance	9, 950
Research and development	10, 920
Construction supervision	9, 910
Consulting	12, 990
Other	10, 040

Source: National Society of Professional Engineers, *Income and Salary Survey, 1962.*

1962 salaries of these personnel ranged from $5,800 for instructors to $16,000 for deans. At all ranks, however, many engineering educators supplemented their teaching salaries by other professional income, since total median income was higher than salary in every instance. Salaries increased for all ranks between 1960 and 1962, ranging from 8 percent for instructors to nearly 19 percent for deans. (See table IV–47.)

The level of degree held by engineering teachers bears a direct relationship to the salary and income earned in both public and private institu-

[11] The report is part of a biennial series of surveys of salaries and professional income of engineering teachers conducted by the Engineers Joint Council through its Engineering Manpower Commission in cooperation with the American Society for Engineering Education. The data in the report are based on returns from 7,371 engineering teachers in public and private colleges and universities throughout the United States.

TABLE IV–47.—*Median salaries and incomes of engineering teachers, by rank, 1960 and 1962*

Rank	1960		1962		Percent change [1]	
	Median salary	Median income	Median salary	Median income	Median salary	Median income
Lecturer	$6, 100	$7, 500	$6, 700	$8, 700	9. 8	15. 6
Instructor	5, 400	6, 600	5, 800	6, 900	8. 0	6. 6
Assistant professor	6, 800	8, 500	7, 500	9, 300	10. 3	9. 4
Associate professor	8, 200	10, 300	9, 100	11, 300	11. 0	10. 2
Professor	10, 500	13, 200	12, 000	15, 000	14. 3	13. 6
Department head	11, 700	13, 700	13, 000	15, 000	11. 1	9. 5
Dean	13, 500	15, 400	16, 000	17, 200	18. 5	11. 3

[1] Percent change based on actual data rather than rounded figures shown.

Source: Engineers Joint Council, Engineering Manpower Commission, *1962 Salaries and Income of Engineering Teachers, 1963.*

tions of higher education. Both median salaries and incomes in 1962 rose significantly with higher degrees. (See table IV–48.)

The differences in both salaries and incomes based on degree held were greater in public than in private institutions. In public institutions the salaries of doctorate holders were about 48 percent above those of the bachelor's level, and in private institutions they were approximately 30 percent higher. The differences in total professional incomes were even greater between those with the bachelor's and those with doctorate degrees—about 59 and 50 percent, respectively, at public and private institutions.

TABLE IV–48.—*Median salaries and incomes of engineering teachers, by type of institution and level of degree, 1962*

Level of degree	Public institutions		Private institutions	
	Median salary	Median income	Median salary	Median income
Bachelor's	$7, 000	$8, 000	$7, 500	$9, 000
Master's	8, 300	9, 900	8, 300	10, 100
Ph.D. or Sc.D	10, 300	12, 700	10, 000	13, 500

Source: Engineers Joint Council, Engineering Manpower Commission, *Salaries and Income of Engineering Teachers, 1962.*

Salaries of Chemists and Engineers in Industry

For several years, the Bureau of Labor Statistics has conducted a series of nationwide surveys of compensation for selected professional, administrative, technical, and clerical occupations in private industry. The information reflects salaries at different work levels, which indicate the degree of experience and responsibility and the scope of job duties in each occupation category. Chemists and engineers were among the occupations surveyed in the professional group.[12]

This report shows the median monthly and annual salaries for chemists and engineers in early 1963 at eight work levels. (See table IV–49.) These levels progress in scope from the professional trainee level (I), typically requiring a bachelor's degree or the equivalent in education and experience combined, to the highest level (VIII), involving a high degree of responsibility in a broad and complex program. Median annual salaries ranged from $6,444 for chemists I to $19,512 for chemists VIII, and from $6,996 for engineers I to $19,680 for engineers VIII. At level IV, which included the largest number of employees in each series, the salaries were $10,128 and $10,620 for chemists and engineers, respectively. It should also be noted that the BLS survey covered 270,000 engineers, the largest number covered in any nationwide salary survey.

Median salaries increased overall 3.8 percent for chemists and 4.4 percent for engineers between 1962 and 1963; however, there were considerable differences in the range of the increases at various work levels. As table IV–49 indicates, the percent increase for chemists at different levels ranged from 2 percent to about 5 percent, compared with from 2 percent to almost 6 percent for engineers.

[12] For description of the occupational definitions at different work levels, see U.S. Department of Labor, Bureau of Labor Statistics, *National Survey of Professional, Administrative, Technical, and Clerical Pay, February–March 1963,* app. B.

TABLE IV-49.—*Median salaries for chemists and engineers at different salary levels in private industry, February–March 1963, and percent increase from February–March 1962*

Occupation	Monthly salaries			Annual salaries			Percent increase in salaries, 1962 to 1963
	Median	1st quartile	3d quartile	Median	1st quartile	3d quartile	
Chemists							
Chemists I	$1, 537	$492	$582	$6, 444	$5, 904	$6, 984	4. 3
Chemists II	590	546	646	7, 080	6, 552	7, 752	4. 0
Chemists III	680	621	754	8, 160	7, 452	9, 048	4. 2
Chemists IV	844	752	949	10, 128	9, 024	11, 388	3. 1
Chemists V	1, 022	909	1, 149	12, 264	10, 908	13, 788	3. 7
Chemists VI	1, 159	1, 034	1, 303	13, 908	12, 408	15, 636	4. 8
Chemists VII	1, 342	1, 216	1, 558	16, 104	14, 592	18, 696	2. 0
Chemists VIII	1, 626	1, 448	1, 813	19, 512	17, 376	21, 756	4. 4
Engineers							
Engineers I	583	558	618	6, 996	6, 696	7, 416	5. 2
Engineers II	641	602	686	7, 692	7, 224	8, 232	3. 2
Engineers III	743	682	805	8, 916	8, 184	9, 660	3. 2
Engineers IV	885	806	974	10, 620	9, 672	11, 688	4. 7
Engineers V	1, 033	924	1, 152	12, 396	11, 088	13, 824	5. 6
Engineers VI	1, 198	1, 045	1, 339	14, 376	12, 540	16, 068	4. 8
Engineers VII	1, 426	1, 278	1, 572	17, 112	15, 336	18, 864	3. 9
Engineers VIII	1, 640	1, 461	1, 841	19, 680	17, 532	22, 092	2. 1

Source: U.S. Department of Labor, Bureau of Labor Statistics, *National Survey of Professional, Administrative, Technical, and Clerical Pay, February–March 1963.*

Salaries of Scientists and Engineers in the Federal Government

Detailed information on the salaries of natural and social scientists and engineers in the Federal Government is available from a 1962 survey conducted by the Civil Service Commission. The survey, covering all departments and agencies, shows that the average (mean) salary for all scientists and engineers employed in the Federal Government in October 1962 was about $10,200. (Since October 1962, Federal Government salaries have been raised several times thereby resulting in a higher average salary for all scientists and engineers at present.) According to the Government's occupational series classification system, personnel in the physical sciences, engineering, the health sciences (M.D.'s, D.D.S.'s, and D.V.M.'s only), the social sciences, psychology, and the operations research groups all had salaries above the average; those in mathematics, the biological sciences, and geography and cartography groups, below the average.

Within the physical sciences, the highest average salary—about $12,700—was earned by personnel in the general physical sciences series. This was considerably higher than the average for all physical scientists as well as for the average salaries in the next 3 ranking series—astronomy and space sciences, physics, and metallurgy—all of which were above $10,500. Below $10,500 were salaries in chemistry (the group with the largest number of employees), meteorology, geology, and a number of the smaller series.

In the mathematics group, those in actuarial work and mathematical statistics had higher average salaries than those in mathematics proper. In addition, many of the 300 personnel in operations research probably utilize advanced mathematical training; the salary of nearly $13,800 for this group was higher than for any other series. (See table IV-50.)

The overall average salary of almost $10,700 for all the engineering series combined was surpassed largely by the salaries in general and materials engineering. In all of the other engineering series, the averages were over $10,000, except in civil engineering, where the average was slightly less.

The lowest average salary of the major groups was about $8,400 in the biological sciences. How-

TABLE IV-50.—*Mean salaries of scientists and engineers employed in the Federal Government, by series, October 1962*

Series	Number of persons	Mean salary
Total	144, 122	$10, 225
Physical sciences	23, 043	10, 650
General physical sciences	5, 137	12, 681
Physics	4, 596	10, 760
Geophysics	280	9, 925
Chemistry	6, 789	9, 563
Metallurgy	581	10, 653
Astronomy and space sciences	249	11, 069
Meteorology	2, 123	10, 203
Geology	1, 827	10, 132
Geodesy	260	9, 798
Technology	494	10, 167
All other physical sciences	707	9, 099
Mathematics (selected categories)	5, 163	9, 732
Actuary	62	10, 860
Mathematics	2, 532	9, 293
Mathematical statisticians	317	11, 006
Statistics	2, 252	10, 019
Engineering	67, 500	10, 680
General engineering	9, 374	12, 143
Materials engineering	601	11, 181
Civil	18, 304	9, 974
Mechanical	17, 250	10, 718
Electrical and electronics	14, 721	10, 785
Chemical	1, 195	10, 494
Industrial	2, 175	10, 250
All other engineering	3, 880	10, 139
Biological sciences	23, 666	8, 440
Biology (general)	831	9, 027
Agricultural sciences	10, 696	8, 275
Microbiology and bacteriology	1, 051	9, 103
Animal sciences	902	9, 887
Plant sciences	1, 550	8, 641
Forestry	5, 758	8, 306
Fishery and wildlife sciences	1, 345	8, 131
All other biological sciences	1, 533	7, 660
Health (selected categories)	14, 640	10, 557
Medical officer	11, 202	10, 676
Dental officer	1, 236	11, 133
Veterinary	2, 202	9, 637
Social sciences (selected categories)	5, 479	10, 417
Social science	885	9, 762
Economics	3, 984	10, 983
History	485	9, 645
Anthropological sciences	125	9, 625
Geography and cartography	2, 389	8, 126
Psychology	1, 815	10, 639
Operations research	427	13, 759

Source: National Science Foundation from U.S. Civil Service Commission data.

ever, almost 70 percent of the persons in this group were in the agricultural sciences and forestry, which had a below average salary. Personnel in almost all of the other biological series had average salaries of over $8,000.

Salaries of Scientists and Engineers Engaged in Research and Development

From the *1964 National Survey of Professional Scientific Salaries* conducted by the Los Alamos Scientific Laboratory of the University of California, data have been obtained on median salaries of scientists and engineers engaged in research and development. The survey covered personnel in private industry, research institutes, private consultants, AEC contractors, and Government laboratories. The 1964 survey provided salary information on 166,000 scientists and engineers with college degrees. The information was obtained from the employers, not the individual employees. The fields of degrees reported to the survey were distributed as follows: engineering, 63.2 percent; chemistry, 13.6 percent; physics, 9.9 percent; mathematics, 5.4 percent; biology, 1.8 percent; metallurgy, 1.2 percent; geology, 0.4 percent; and other fields, 5.4 percent. Data on salary by individual scientific occupation were not obtained.

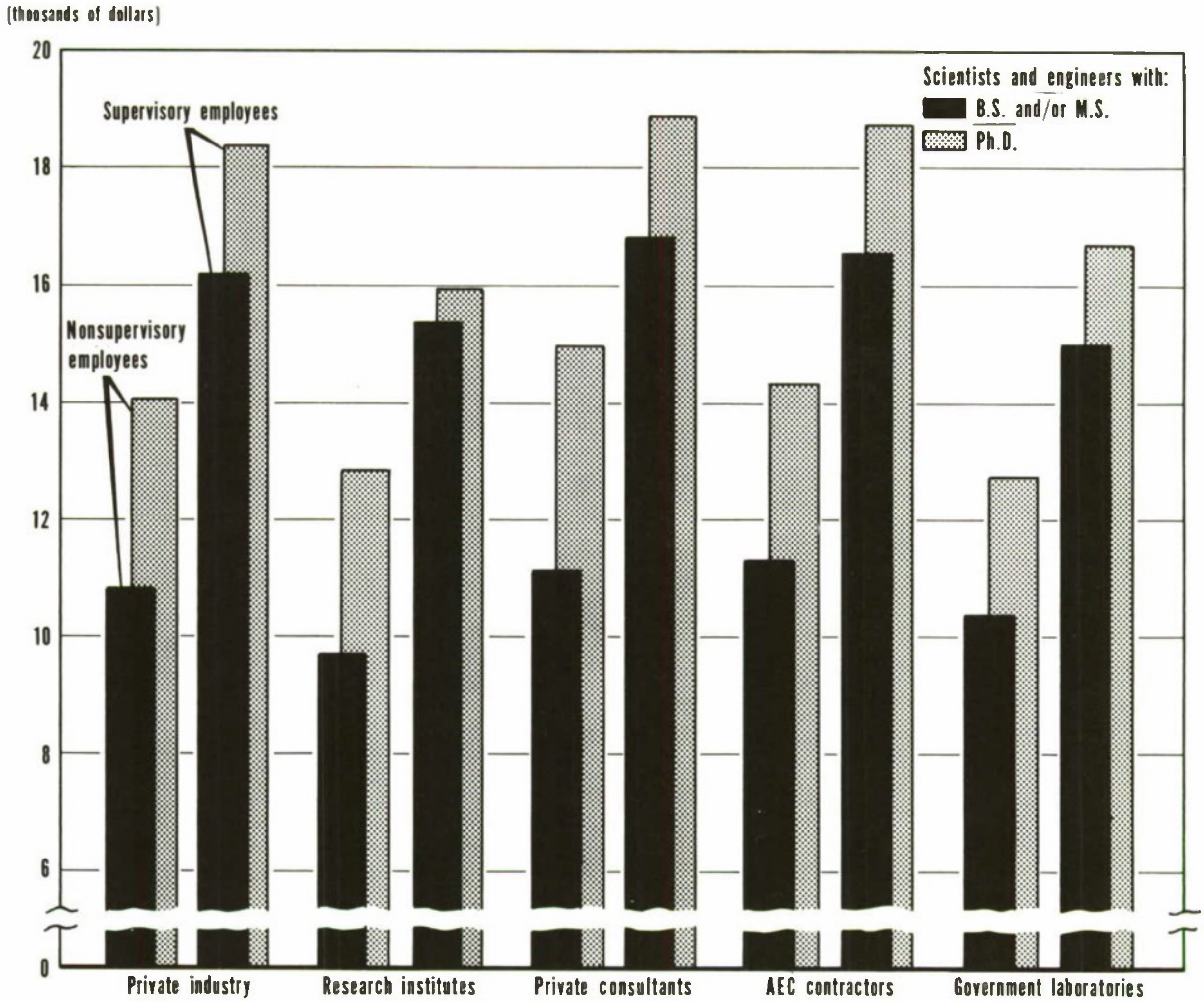
Median annual salaries of nonsupervisory and supervisory personnel, both for those holding B.S. or M.S. degrees, and those with Ph. D. degrees, by selected years of experience, are shown in tables IV-51, 52, 53, and 54.

As might be expected, the highest salaries are shown for supervisory employees holding Ph.D. degrees, the lowest for nonsupervisory employees with B.S. or M.S. degrees—$18,084 compared with $10,776. It appears that supervisory employees in research and development are likely to command higher salaries than others whether they have obtained the doctorate or not, although the attainment of a doctorate is associated with a higher salary level within both groups. There is a greater gap between B.S.-M.S.-level and Ph.D.-level employees in nonsupervisory capacities than among similar employees in supervisory capacities. The difference for nonsupervisory personnel amounts to about $3,200, but for supervisory personnel only $2,200. Supervisory employees with B.S.-M.S. degrees had median

salaries greater by $1,900 than those of nonsupervisory employees with the Ph.D. For both supervisory and nonsupervisory employees regardless of level of degree held, private consultants and AEC contractors paid the highest salaries (chart IV–9).

Although, in general, median salaries rose with increasing experience (assumed from the number of years since the B.S.), in most cases a fluctuation occurred in the middle years of experience, where median salaries did not necessarily rise in a steady progression.

Chart IV–9. Median annual salaries of R&D scientists and engineers, by selected type of employer, 1964



Source: University of California, Los Alamos Scientific Laboratory.

TABLE IV–51.—*Median annual salaries for nonsupervisory employees in research and development holding a B.S. or M.S. degree, by type of employer and by selected years since B.S. degree, 1964*

Employer	Number of persons	Median salaries by number of years since bachelor's degree: Total	Less than 1	5	10	12	13	14	15	16	17	18–22	23–27	28–32	33–37	38–42
All employers	125,414	$10,776	$7,416	$10,068	$11,796	$12,336	$12,576	$12,624	$13,020	$13,368	$13,176	$13,464	$13,572	$13,356	$13,044	$12,684
Private industry	93,679	10,860	7,536	10,116	11,880	12,456	12,744	12,768	13,152	13,452	13,260	13,512	13,644	13,464	13,152	12,948
Research institutes	4,470	9,768	6,300	9,216	10,800	11,688	12,180	12,432	12,324	12,204	11,544	12,732	13,776	12,360	12,300	12,048
Private consultants	2,501	11,112	5,364	9,816	12,096	12,384	12,888	13,752	13,332	13,368	14,544	13,176	13,680	13,848	15,444	11,400
AEC contractors	8,184	11,292	7,548	9,804	11,760	12,360	12,372	12,492	12,984	13,392	13,152	13,572	13,560	13,692	12,744	12,948
Government laboratories	16,580	10,380	6,912	10,152	11,580	12,036	12,204	12,204	12,456	12,972	12,624	13,308	13,068	12,684	12,300	11,688

Source: Los Alamos Scientific Laboratory, *1964 National Survey of Professional Scientific Salaries.*

TABLE IV–52.—*Median annual salaries of nonsupervisory employees in research and development holding a Ph.D. degree, by type of employer and by selected years since B.S. degree, 1964*

Employer	Number of persons	Median salaries by number of years since bachelor's degree: Total	3–4	5	10	15	16	17	18	19	20	21	22	23–27	28–32	33–37	38–42
All employers	13,408	$13,968	$11,832	$11,856	$13,128	$14,676	$14,928	$15,456	$15,432	$14,832	$15,516	$15,624	$15,684	$15,732	$16,260	$16,272	$15,444
Private industry	8,972	14,028	12,168	11,952	13,248	14,532	14,772	15,060	15,540	14,604	15,552	15,612	15,624	15,612	16,332	16,344	15,708
Research institutes	1,144	12,840	8,400	11,718	10,728	14,052	14,304	16,872	12,504	14,400	13,704	15,600	15,540	15,540	16,344	15,996	13,044
Private consultants	439	14,952	12,600	12,600	12,300	15,744	16,200	16,200	16,800	15,300	16,500	14,700	17,700	16,728	17,100	17,400	20,400
AEC contractors	2,184	14,292	12,048	11,580	13,488	15,180	15,672	16,020	15,360	15,744	16,236	16,044	16,464	16,320	15,600	16,200	16,404
Government laboratories	669	12,756	11,184	9,900	12,084	14,004	14,280	13,500	14,244	13,428	13,944	13,200	14,304	14,400	14,736	15,000	14,700

Source: Los Alamos Scientific Laboratory, *1964 National Survey of Professional Scientific Salaries.*

TABLE IV–53.—*Median annual salaries of supervisory employees in research and development holding a B.S. and/or M.S. degree, by type of employer and by selected years since B.S. degree, 1964*

Employer	Number of persons	Median salaries by number of years since bachelor's degree: Total	5	10	15	16	17	18	19	20	21	22	23–27	28–32	33–37	38–42	43–47
All employers	22,118	$15,900	$11,964	$14,388	$16,260	$16,728	$16,776	$17,424	$17,100	$17,280	$17,220	$17,268	$17,256	$16,872	$17,100	$17,532	$17,808
Private industry	16,493	16,164	12,660	14,736	16,632	17,112	16,992	17,928	17,208	17,592	17,508	17,784	17,712	17,124	17,568	18,300	18,204
Research institutes	537	15,360	9,432	14,244	15,600	16,404	16,296	15,000	15,000	13,500	15,900	17,928	17,772	16,644	15,900	15,000	------
Private consultants	454	16,800	9,804	15,672	17,460	17,400	17,100	17,400	17,100	18,300	18,000	17,172	18,084	19,500	18,600	18,900	15,900
AEC contractors	1,118	16,524	11,400	13,548	16,212	16,296	17,016	16,704	17,772	17,520	17,784	18,000	17,676	17,652	17,100	16,800	------
Government laboratories	3,516	14,496	11,532	13,344	14,760	15,408	14,868	16,380	15,300	15,816	16,572	16,200	15,924	16,284	16,248	14,040	13,800

Source: Los Alamos Scientific Laboratory, *1964 National Survey of Professional Scientific Salaries.*

TABLE IV–54.—*Median annual salaries of supervisory employees in research and development holding a Ph.D. degree, by type of employer and by selected years since B.S. degree, 1964*

Employer	Number of persons	Median salaries by number of years since bachelor's degree: Total	5	10	15	16	17	18	19	20	21	22	23–27	28–32	33–37	38–42	43–47
All employers	5,040	$18,084	$15,444	$15,240	$17,256	$17,808	$18,324	$18,696	$18,504	$18,696	$18,552	$19,140	$19,116	$19,500	$20,040	$19,572	$19,272
Private industry	3,243	18,348	16,200	15,660	17,280	17,988	18,624	18,948	19,044	19,272	18,756	19,368	19,272	20,136	20,700	20,220	19,644
Research institutes	549	15,924	11,196	11,352	16,428	15,528	16,500	16,200	14,700	15,972	17,796	16,200	17,544	18,300	19,500	16,644	12,000
Private consultants	170	18,876	------	18,000	18,600	19,200	19,944	19,800	19,200	18,300	21,696	20,400	21,060	19,044	21,600	16,800	17,400
AEC contractors	707	18,720	------	14,700	18,132	18,600	19,140	18,972	18,252	19,128	18,660	18,900	20,004	19,692	19,872	21,300	19,500
Government laboratories	371	16,692	15,696	14,100	14,916	15,900	16,428	17,700	15,900	18,072	16,944	18,600	17,100	17,292	18,204	16,800	17,100

Source: Los Alamos Scientific Laboratory, *1964 National Survey of Professional Scientific Salaries.*

The range in medians among employees with varying years of experience was greatest for B.S.–M.S. scientists in nonsupervisory positions, with a difference of about $6,200 ($7,416 for those with less than 1 year of experience and $13,572 with 23–27 years of experience). For Ph.D. employees in supervisory positions, the range was from about $4,600 to $15,444 for those with 5 years of experience to more than $20,000 for those at the highest level after 33–37 years of experience. However, in both cases the differences varied considerably by type of employer.

Technical Notes

The information from the National Register of Scientific and Technical Personnel presented in this report shows characteristics of scientific personnel by the scientific and technical fields with which they are associated. The listing below shows the subfields included within each broad scientific and technical field. The following Specialties List sent to each respondent in the 1962 National Register presents a finer breakdown of the scientific subfields.

Agricultural sciences

Agronomy
Animal husbandry
Fish and wildlife
Forestry and range sciences
Horticulture
Soil specialties

Biological sciences

Anatomy
Bacteriology
Botany
Ecology
Entomology
Genetics
Immunology
Nutrition
Pathology
Pharmacology
Physiology
Phytopathology
Virology
Zoology
Biology, other
Biophysics

Psychology

Clinical psychology
Counseling and guidance
Developmental psychology
Educational psychology
General psychology
Industrial and personnel psychology
Personality
Programmed learning
School psychology
Social psychology
Psychology, other
Experimental, comparative, and physiological psychology
Psychometrics

Earth sciences

Geochemistry
Geodesy
Geology
Paleontology and paleobotany
Solid-earth geophysics
Geography
Hydrology
Oceanography
Atmospheric, lithospheric, and hydrospheric specialties, other

Meteorology

Atmospheric dynamics, chemistry and physics
Climatology
Synoptic meteorology
Area specialization
Meteorological instrumentation

Mathematics and statistics

Algebra
Analysis and functional analysis
Geometry
Logic
Mathematics of resource use
Number theory
Numerical methods and computation
Topology
Probability
Statistics
Mathematics, other

Physics and astronomy

Acoustics
Atomic and molecular physics
Electromagnetic waves and electron physics
Elementary particle physics
Mechanics
Nuclear structure physics
Optics
Physics of fluids
Solid state
Theoretical physics
Thermal phenomena
Physics, other
Astronomy
Electronics

Chemistry

Analytical chemistry
Inorganic chemistry
Organic chemistry
Chemistry, other
Agricultural and food chemistry
Biochemistry
Physical chemistry

Sanitary engineering

Other fields

Aeronautical engineering

Ceramic engineering
Chemical engineering
Civil engineering
Electrical engineering
Engineering mechanics
Industrial engineering
Mechanical engineering
Metallurgy and metallurgical engineering
Mining and petroleum engineering
Other engineering
Photogrammetry, photointerpretation, cartography
Social sciences, humanities and other specialties

Specialties List for use with National Register of Scientific and Technical Personnel

ATMOSPHERIC, LITHOSPHERIC, AND HYDROSPHERIC SPECIALTIES

Atmospheric Dynamics, Chemistry and Physics

3001—Aeronomy
3002—Airglow
3003—Atmospheric chemistry
3004—Atmospheric electricity
3005—Atmospheric optics and acoustics
3006—Atmospheric thermodynamics
3007—Aurora
3008—Cloud and precipitation physics
3010—Composition
3011—Dynamics of atmospheric motion
3012—Magneto hydrodynamics
3013—Planetary atmospheres
3014—Radiation
3015—Solar-terrestrial relationships
3016—Turbulence and diffusion
3009—Other (specify)

Climatology

3101—Bioclimatology
3102—Microclimatology
3103—Paleoclimatology
3104—Physical climatology
3105—Synoptic climatology
3109—Other (specify)

Synoptic Meteorology

3201—Hydrometeorology
3202—Mesometeorology
3203—Micrometeorology
3204—Numerical analysis and prediction
3205—Observations
3206—Radar meteorology
3207—Weather analysis and forecasting
3209—Other (specify)

Area Specializations

3301—Agricultural meteorology
3345—Air pollution
3302—Aviation meteorology
3303—Marine meteorology
3304—Polar meteorology
3305—Tropical meteorology
3309—Other (specify)

Meteorological Instrumentation

3401—Automatic data sensing systems
3402—Balloon sounding systems
3403—Radar and radio instrumentation
3404—Rocket sounding systems
3405—Satellite instrumentation
3409—Other (specify)

Geochemistry

1001—Cosmochemistry
1002—General inorganic geochemistry
1003—Isotopes and geochronology
1004—Mineral synthesis and stability relations of minerals
1005—Organic geochemistry
1009—Other (specify)

Geodesy

1101—Earth motions
1102—Geodetic instrumentation
1103—Geodetic surveying
1403—Gravity
1104—Navigation, geodetic astronomy
1109—Other (specify)

Geology

1201—Areal geology
1202—Engineering geology
1203—General field geology
1204—Geology of ground water
1205—Geology of mineral deposits
1206—Geology of petroleum deposits
1207—Geology of solid fuels
1208—Glacial geology
1210—Geomorphology
1211—Mineralogy and crystallography
1212—Petrography and petrology, igneous and metamorphic
1213—Petrography and petrology, sedimentary
1214—Photogeology
1215—Stratigraphy
1216—Structural geology, igneous and metamorphic
1217—Structural geology, sedimentary
1209—Other (specify)

Paleontology and Paleobotany

1301—Micropaleontology
1302—Paleobotany
1303—Paleontology, invertebrate
1304—Paleontology, vertebrate
1305—Palynology
1309—Other (specify)

Solid-Earth Geophysics

1401—Geomagnetism and electricity
1402—Geophysical surveying
1403—Gravity
1404—Heat flow
1405—Physical properties of materials
1406—Physics of volcanoes
1407—Seismology, induced vibrations
1408—Seismology, natural vibrations
1410—Tectonophysics
1409—Other (specify)

Geography

1501—Biogeography
1502—Cultural geography
1503—Economic geography
1504—Historical geography
1505—Military geography
1506—Philosophy of geography
1507—Physical geography
1508—Political geography
1510—Regional geography (specify region)
1511—Theoretical geography
1512—Toponymy
1509—Other (specify)

Hydrology

1601—Chemistry of water
1602—Erosion and sedimentation
1603—Evaporation and transpiration
1604—Glaciology
1605—Ground waters
1606—Precipitation
1607—Snow, ice and permafrost
1608—Soil moisture
1610—Surface waters
1609—Other (specify)

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Oceanography

1701—Biological oceanography
1702—Chemical oceanography
1703—Descriptive oceanography
1704—Hydrography
1705—Ocean-bottom processes
1706—Physical oceanography
1707—Sea-air interactions
1708—Shore and near shore processes
1710—Underwater sound
1709—Other (specify)

1909—*Atmospheric, lithospheric, and hydrospheric specialties, other (specify)*

BIOLOGY

Please use the specific specialties and the four-digit codes. A number of biological specialties, at the end of this biology section, appropriate to more than one subfield, have only two digits. Please indicate your appropriate subfield and specialties as follows: If your biological subfield is bacteriology (7X) and your specialization is metabolism (..80), code as 7X80; however, if your biological subfield is physiology (78) and your specialization is metabolism (..80), code as 7880.

Anatomy

7Y01—Comparative
7Y02—Gross
7Y03—Microscopic
7Y04—Neuroanatomy
7Y05—Systemic
7Y06—Topographic

Bacteriology

7X01—Bacterial metabolism
7X02—Bacterial physiology
7X03—Microbial processes

Botany

7001—Bryology
7002—Dendrology
7003—Mycology
7004—Nutrition and growth
7005—Parasitology
7006—Phycology
7007—Plant anatomy
7008—Plant physiology
7010—Pteridology
7011—Systematics of higher plants

Ecology

7101—Animal ecology
7102—Plant ecology
7103—Zoogeography

Entomology

7201—Agricultural
7202—Apiculture
7203—Control, chemical
7204—Control, other
7205—Forest
7206—Insect pests
7207—Insect physiology, morphology
7208—Medical

Genetics

7301—Animal
7302—Human
7303—Microorganisms
7304—Plant
7305—Population studies

Immunology

7401—Antibody formation
7402—Antigens and antibodies
7403—Antigens—antibody reaction
7404—Complement
7405—Hypersensitivity
7406—Infection and resistance
7407—Interference; latency
7408—Tissue antibodies; autoantibodies

Nutrition

7501—Animal nutrition
7502—Clinical nutrition
7504—Nutrient value of foods
7505—Requirements and deficiencies

Pathology

7601—Clinical
7602—Comparative
7603—Cytopathology, histopathology
7604—Experimental

Pharmacology

7701—Chemical pharmacology
7702—Chemotherapy
7703—Drug enzymology
7704—Experimental therapeutics, clinical
7705—Industrial chemicals
7706—Neuropharmacology
7707—Pharmacodynamics
7708—Psychopharmacology
7710—Toxicology

Physiology

7801—Neurophysiology
7802—Reproduction
7803—Respiratory

Phytopathology

7901—Bacterial
7902—Disease control, chemical
7903—Disease control, other
7904—Fungal
7905—Host resistance
7906—Nematodal
7907—Physiogenic
7908—Viral

Virology

8Y01—Arbor viruses
8Y02—Enteric viruses
8Y03—Pox viruses
8Y04—Respiratory viruses
8Y05—Tumor viruses

Zoology

8X01—Herpetology
8X02—Ichthyology
8X03—Invertebrate
8X04—Mammalogy
8X05—Ornithology
8X06—Parasitology
8X07—Protozoology
8X08—Vertebrate

Agronomy

8401—Crop breeding, hybridization
8402—Crop management
8403—Field crops
8404—Pasture and forage crops
8405—Seeds
8406—Turf and ornamental crops
8407—Weed control

Animal Husbandry

8501—Large animal
8502—Poultry
8503—Small animal

Fish and Wildlife

8601—Controls
8602—Food habits
8603—Habitat influences
8604—Population dynamics
8605—Propagation and management

Forestry and Range

8701—Erosion control
8702—Forestry management
8703—Forest products
8704—Forest protection
8705—Irrigation
8706—Range management
8707—Silviculture
8708—Watershed management

Horticulture

8801—Floriculture and ornamentals
8802—Fruits
8803—Vegetables

Other Biological Specialties

7Y.....Anatomy
7X.....Bacteriology
70......Botany
71......Ecology
72......Entomology
73......Genetics
74......Immunology
75......Nutrition
76......Pathology
77......Pharmacology
78......Physiology
79......Phythopathology

8Y-----Virology
8X-----Zoology
84------Agronomy
85------Animal Husbandry
86------Fish and Wildlife
87------Forestry and Range Science
88------Horticulture
to be used with:
--45—Air pollution
--46—Amino acids, peptides, proteins
--47—Anesthesiology
--48—Anthropology
--49—Antibiotics
--50—Aviation—space biology
--51—Biologicals
--52—Biology documentation
--53—Bio-optics
--54—Blood groups
--55—Breeding, hybridization
--56—Carbohydrates
--57—Cardiovascular system
--58—Cell tissue biology
--59—Central nervous system
--60—Conservation
--61—Cytology
--62—Demography
--63—Development and growth
--64—Electrolyte
--65—Electron microscopy
--66—Endocrinology
--67—Environmental biology
--44—Enzymes
--68—Epidemiology
--69—Fatty acids; fats
--70—Food additives
--71—Gastroenterology
--72—Hematology
--73—Immunochemistry
--74—Industrial hygiene and occupational health
--75—Ionizing radiation
--76—Isotopes
--77—Limnology
--78—Lipids
--79—Marine
--80—Metabolism
--81—Methodology
--82—Morphology
--83—Muscle
--84—Nucelo proteins
--85—Oncology
--86—Organ systems
--87—Photosynthesis
--88—Psychiatry
--89—Radiation biology
--90—Renal system
--91—Serology
--92—Standardizations
--93—Steroids
--94—Taxonomy
--95—Technology
--96—Tissue culture
--97—Trace elements
--98—Transplantation
--99—Transport
--43—Vitamins

8909—*Biology, other (specify)*

CHEMISTRY

Analytical Chemistry

0001—Absorption spectroscopy
0002—Chemical microscopy
0003—Chromatographic analysis
0004—Electromeric analysis
0005—Emission spectroscopy
0006—Gas analysis
0007—Gravimetric analysis
0008—Mass spectroscopy
0010—Microchemistry
0011—Nucleonics
0012—Qualitative analysis
0013—Solvent extraction
0014—Volumetric analysis
0015—X-ray analysis
0009—Other (specify)

Inorganic Chemistry

0101—Alkalics and compounds
0102—Alkaline earths and compounds
0103—Atomic nuclei
0104—Boron family
0105—Building products; cement, lime, etc.
0106—Carbon family
0107—Clay and clay products
0108—Coordination compounds
0110—Electronic materials; semiconductors, ferroelectrics, ferromagnetics
0111—Explosives, rocket fuels
0112—Extranuclear structure
0113—Glass, fused silica
0114—Halogen family
0115—Hydrogen
0116—Industrial carbon, graphite, carbon black
0117—Inner-transition elements, lanthanide series and actinide series
0118—Nitrogen family
0019—Nonmineral products; asbestos, vermiculite, etc.
0120—Oxygen family
0121—Pigments and industrial minerals
0122—Radioactive minerals and products
0123—Solutions and solvent theory
0124—Theoretical inorganic chemistry
0125—Transition elements
0109—Other (specify)

Organic Chemistry

0201—Adhesives
0202—Agricultural chemicals
0203—Aliphatic chemistry
0204—Alkaloids
0205—Amino acids and proteins
0206—Antibiotics
0207—Aromatic hydrocarbons, derivatives
0208—Carbohydrates
0210—Coal
0211—Dyestuffs
0212—Elastomers and related products
0213—Explosives and rocket fuels
0214—Fluorine compounds
0215—Free radical
0216—Heterocycles
0217—Ion exchange resins
0218—Oils, fats, waxes
0219—Organometallics
0220—Petroleum
0221—Pharmaceuticals
0222—Phosphorus compounds
0223—Photo products
0224—Plastics and synthetic resins
0225—Protective coatings
0226—Reaction mechanisms
0227—Silicon compounds
0228—Small ring compounds
0229—Soaps, detergents, surfactants
0230—Sterochemistry
0231—Steroids
0232—Terpenes and other alicyclics
0233—Textiles and related products
0234—Use of isotopes
0235—Wood, paper and cellulose
0209—Other (specify)

0909—*Chemistry, other (specify)*

MATHEMATICS AND STATISTICS

Algebra

2X01—Boolean algebra
2X02—Combinatorial analysis
2X03—Differential algebra
2X04—Fields, rings, algebras
2X05—Groups, generalizations
2X06—Homological algebra
2X07—Lattices
2X08—Linear algebra and matrix theory
2X10—Order, total and partial
2X11—Polynomials
2X12—Representation theory
2X09—Other (specify)

Analysis and Functional Analysis

2001—Banach spaces and algebras
2002—Calculus of variations
2003—Convexity, inequalities
2004—Difference equations, functional equations
2005—Functions of real variables
2006—Functions of a complex variable
2007—Functions of several complex variables
2008—Hilbert spaces
2010—Integral equations
2011—Integral transforms
2012—Interpolation, approximation
2013—Lie groups and algebras
2014—Measure, integration, area
2015—Operational calculus
2016—Ordinary differential equations
2017—Partial differential equations
2018—Potential theory, subharmonic functions
2019—Series, summability
2020—Set theory
2021—Special functions
2022—Trigonometric series and integrals
2009—Other (specify)

Geometry

2101—Affine geometry
2002—Algebraic geometry
2103—Complex manifolds
2104—Convex domains, extremum problems
2105—Differential geometry, tensor analysis
2106—Euclidean geometry
2107—Finite geometries
2108—Foundations
2110—Integral geometry
2111—Projective, non-Euclidean geometries
2112—Riemannian geometry
2109—Other (specify)

Logic

2201—Applications of logic
2202—Formal and symbolic logic
2203—Foundations of mathematics
2204—Intuitionism
2205—Recursive functions
2209—Other (specify)

Mathematics of Resource Use

2301—Activity analysis
2302—Actuarial mathematics
2303—Biometrics, biostatistics
2304—Control systems
2305—Cryptography
2306—Dynamic programming
2307—Econometrics
2308—Game theory
2310—Information and communication theory
2311—Logistics, inventory
2312—Operations research
2313—Weapons systems evaluation
2309—Other (specify)

Number Theory

2401—Algebraic number theory
2402—Analytic number theory
2403—Diophantine approximation
2404—Elementary number theory
2405—Geometry of numbers
2409—Other (specify)

Numerical Methods and Computation

2501—Algorithm construction
2502—Analogue systems, coding and programming
2503—Difference and functional equations
2504—Digital computers, coding and programming
2505—Digital computers, logic and design
2506—Eigenvalues, Raleigh-Ritz method
2507—Error analysis
2508—General methods, iteration
2510—Interpolation, approximation, curve-fitting
2511—Integral and integro-differential equations
2512—Linear equations, matrices
2513—Nomography, tables
2514—Numerical differentiation, quadrature
2515—Ordinary differential equations
2516—Partial differential equations
2517—Special functions
2509—Other (specify)

Topology

2601—Abstract spaces
2602—Applications to analysis
2603—Fibre bundles and spaces
2604—Graphs
2605—Homology, cohomology
2606—Homotopy
2607—Manifolds, Kaehler spaces
2608—Mappings
2610—Point-set topology
2611—Topological dynamics
2612—Topological groups
2609—Other (specify)

Probability

2701—Analytic probability theory
2702—Applications of probability
2703—Foundations of probability
2704—Limit theorems
2705—Stochastic processes, general
2706—Markov processes
2707—Theory of generating functions
2708—Time series
2709—Other (specify)

Statistics

2801—Analytical statistics
2802—Decision theory, sequential analysis
2803—Design and analysis of experiments
2804—Estimation and testing, parametric
2805—Multivariate analysis
2806—Non-parametric methods
2807—Quality control
2808—Sampling techniques
2810—Survey methods: including forms design, data collection and data processing
2811—Theory of statistical inference
2812—Time series analysis
2809—Other (specify)

2909—*Mathematics, other (specify)*

PHYSICS

Acoustics

4Y01—Applied acoustics, instruments and apparatus
4Y02—Architectual acoustics
4Y03—Bioacoustics
4Y04—Ear and hearing
4Y05—Electroacoustics
4Y06—Mechanical vibrations & shock
4Y07—Musical instruments & music
4Y08—Noise
4Y10—Sound transmission
4Y11—Speech and singing
4Y12—Ultrasonics
4Y13—Underwater sound
4Y09—Other (specify)

Atomic and Molecular Physics

4X01—Atomic mass and abundance
4X02—Atomic and molecular beams
4X03—Structure and spectra
4X04—X-ray phenomena
4X05—X-ray technology
4X09—Other (specify)

Electromagnetic Waves and Electron Physics

4001—Antenna theory
4002—Electrical measurements and instruments
4003—Electron dynamics
4004—Gas discharge
4005—Masers and similar devices
4006—Microwaves
4007—Physical electronics
4008—Radio waves
4009—Other (specify)

Elementary Particle Physics

4101—Cosmic rays
4102—High energy accelerators
4103—High energy particles
4109—Other (specify)

Mechanics

4201—Analytical mechanics
4202—Ballistics
4203—Continuum mechanics
4204—Flight dynamics
4205—Gravity and gravitation
4206—High pressure phenomena
4207—High vacuum techniques
4208—Instrumental measurement (principally mechanical)
4210—Rheology
4209—Other (specify)

Nuclear Structure Physics

4301—Accelerators
4302—Detectors
4303—Nuclear reactions and scattering
4304—Nuclear spectroscopy
4305—Radiation and isotope use
4306—Reactors
4309—Other (specify)

Optics

4401—Atmospheric optics
4402—Color, colorimetry & photometry
4403—Films and coatings
4404—Geometrical optics
4405—Illumination
4406—Lenses
4407—Optical instruments
4408—Photography
4410—Physical optics
4411—Spectroscopy
4412—Vision
4409—Other (specify)

Physics of Fluids

4501—Boundary layer effects
4502—Compressible fluid dynamics
4503—Incompressible fluid dynamics
4504—High-temperature flow
4505—Magneto fluid dynamics
4506—Plasma physics
4507—Plastic flow
4508—Rarefied gas flow
4510—Shock wave phenomena
4511—Structure and properties of gases
4512—Structure and properties of liquids
4513—Superfluidity
4514—Turbulence
4509—Other (specify)

Solid State

4601—Crystallography
4602—Dielectrics (including fluids)
4603—High polymers and glasses
4604—Luminescence
4605—Magnetic resonance
4606—Magnetism in solids
4607—Photoelectric phenomena
4608—Physics of metals
4610—Piezo and ferro-electricity
4611—Radiation damage
4612—Semiconductors
4613—Superconductivity
4614—Surface physics
4615—Thin films
4609—Other (specify)

Theoretical Physics

4701—Field theory
4702—Quantum mechanics
4703—Relativity and gravitation
4704—Statistical mechanics and kinetic theory
4709—Other (specify)

Thermal Phenomena

4801—Cryogenics
4802—Heat radiation and transmission
4803—Temperature & its measurements
4804—Thermodynamics
4809—Other (specify)

4909—*Physics, other (specify)*

ASTRONOMY

9001—Astrometry
9002—Astrophysics
9003—Celestial mechanics
9004—Cosmogony
9005—Cosmology
9006—Design of astronomical instruments
9007—Navigation, geodetic astronomy
9008—Photoelectric photometry
9010—Physics of planets, satellites
9011—Physics of the interstellar medium
9012—Physics of the sun
9013—Radio astronomy
9014—Spectroscopy of astronomical sources
9015—Star systems and statistical astronomy
9016—Stellar energy sources and nucleogenesis
9009—Astronomy, other (specify)

PSYCHOLOGY

Clinical Psychology

5001—Behavior problems
5002—Crime and delinquency
5003—Experimental psychopathology
5004—Group therapy
5005—Individual diagnosis & therapy
5006—Mental deficiency
5007—Objective tests
5008—Projective techniques
5010—Speech pathology
5009—Other (specify)

Counseling and Guidance

5101—Educational counseling
5102—Nondirective therapy
5103—Personal adjustment
5104—Rehabilitation
5105—Vocational counseling
5109—Other (specify)

Developmental Psychology

5201—Nursery and pre-school
5202—Childhood and adolescence
5203—Maturity and old age
5209—Other (specify)

Educational Psychology

5301—Educational measurement
5302—School adjustment
5303—School learning
5304—Special education
5305—Student personnel
5306—Teacher personnel
5309—Other (specify)

General Psychology

5401—History and biography
5402—Theory and systems
5409—Other (specify)

Industrial and Personnel Psychology

5501—Employee and executive training and development
5502—Employee morale and attitudes
5503—Job analysis and position classification
5504—Labor-management relations
5505—Market research, advertising
5506—Performance evaluation, criterion development
5507—Recruiting, selection, placement
5508—Safety research and training
5510—Salary and pay plans
5509—Other (specify)

Personality

5601—Development
5602—Measurement
5603—Personality and body
5604—Personality and learning
5605—Personality and perception
5606—Personality theory
5607—Structure and dynamics
5609—Other (specify)

5Y01—*Programmed Learning*
5X01—*School Psychology*

Social Psychology

5701—Culture and personality
5702—Group interaction
5703—Language and communication
5704—Leadership
5705—Mass media communication
5706—Role differentiation
5707—Social attitudes
5708—Social perception and cognition
5710—Surveys and polls
5709—Other (specify)

5909—*Psychology, other (specify)*

INTERDISCIPLINARY SPECIALTIES

Agriculture and Food Chemistry

9101—Alcoholic beverages
9102—Animal and vegetable fats, oils
9103—Animal feeds
9104—Bakery and confectionery products
9105—Cereals, carbohydrates
9106—Fertilizers, plant growth regulators
9107—Food and feed additives
9108—Fruits, vegetables, juices
9110—Meat, fish, dairy and poultry products
9111—Nonalcoholic beverages
9112—Nonfood crop products
9113—Pesticides (insect, herbi-, fungicides, etc.)
9109—Other (specify)

Biochemistry

9201—Antimetabolites
9202—Biochemical mechanisms
9203—Biochemorphology
9204—Clinical
9205—Cyto-histo-chemistry
9206—Endocrine
9207—Enzyme, co-enzyme
9208—Intermediary metabolism, biosynthesis
9210—Microbiological
9211—Natural pigments (carotenoids)
9212—Neurochemistry
9213—Nucleic acids (purines, pyrimidines)
9214—Physical
9215—Radiation biochemistry
9246—Amino acids, peptides, proteins
9256—Carbohydrates
9273—Immunochemistry
9278—Lipids, (phospho-, glyco-fats, oils)
9281—Technology, methodology
9285—Oncology, carcinogenesis
9293—Steroids
9209—Other (specify)

Biophysics

9301—Bioacoustics and transmission
9302—Biochemical physics
9303—Bioelectricity and transmission
9304—Bio-systems, control, communications
9305—Biothermics and bioenergetics
9306—Biotransport and membrane physics
9307—Cellular biophysics
9308—Fluid biomechanics
9310—Health physics
9311—Mathematical biophysics
9312—Methodology, instrumentation, and measurement
9313—Molecular biophysics
9389—Radiation biology
9315—Solid biomechanics
9316—Theoretical physical biology
9353—Biooptics (physical and geometric)
9365—Electron microscopy
9309—Other (specify)

Electronics

9401—Circuit theory
9402—Computer design & development
9403—Electron tubes
9404—Electronic circuitry
9405—Guidance and control
9406—Instrumental measurement (principally electronic)
9407—Radio communication
9408—Semiconductors
9410—Solid state devices, other
9411—Television systems
9409—Other (specify)

Experimental, Comparative, and Physiological Psychology

9501—Aesthetics
9502—Animal learning
9503—Apparatus design & evaluation
9504—Audition
9505—Autonomic functions
9506—CNS functions
9507—Communications research, information theory
9508—Electroencephalography
9510—Engineering psychology
9511—Fatigue
9512—Feeling and emotion
9513—Motivation
9514—Motor skills
9515—Perception
9516—Psychophysics
9517—Sensory processes
9518—Symbolic processes, problem solving
9519—Vision
9509—Other (specify)

Photogrammetry, Photo-interpretation, Cartography

9601—Aerial photography
9602—Analytical photogrammetry
9603—Ballistic and satellite photogrammetry
9604—Compilation cartography
9605—Design cartography
9606—Interpretation: cultural features
9607—Interpretation: military features
9608—Interpretation: natural features and resources
9610—Interpretation: space features
9611—Reproduction cartography
9612—Sensor imagery
9613—Stereo plotting
9614—Terrestrial photogrammetry
9609—Other (specify)

Physical Chemistry

9701—Catalysis
9702—Chemical kinetics
9703—Colloid chemistry
9704—Determination of physical constants
9705—Electrochemistry
9706—Electrodeposition
9707—Flames and explosives
9708—Fused salts
9710—Gaseous state
9711—High temperature chemistry
9712—Homogeneous chemical equilibrium
9713—Ion exchange and applications
9714—Liquid state
9715—Molecular structure
9716—Phase equilibria
9717—Photochemistry
9718—Polymer chemistry
9719—Quantum theory
9720—Radiation chemistry
9721—Solid, including X-ray methods
9722—Solutions of electrolytes
9723—Solutions of nonelectrolytes
9724—Surface chemistry
9725—Thermochemistry
9726—Thermodynamics
9709—Other (specify)

Psychometrics

9801—Experimental design
9802—Factor analysis
9803—High-speed computers
9804—Mathematical models
9805—Statistical development
9806—Test construction, validation
9807—Test theory, scale analysis
9809—Other (specify)

Soil Specialties

9901—Fertility, management
9902—Soil bacteriology

9903—Soil chemistry
9904—Soil genesis, classification and mapping
9905—Soil mechanics and engineering
9906—Soil mineralogy
9960—Soil conservation
9909—Other (specify)

ENGINEERING

Aeronautical Engineering

6Y01—Aerodynamic loads
6Y02—Aerodynamics
6Y03—Aircraft fuels combustion
6Y04—Aircraft structures
6Y05—Airports, air transport
6Y06—Compressors, turbines
6Y07—Flight test and research
6Y08—Flutter, vibration
6Y10—Hydrodynamics
6Y11—Instrumentation
6Y12—Landing loads
6Y13—Propulsion systems, materials, structure
6Y14—Rotary wing
6Y15—Stability, control
6Y09—Other (specify)

Ceramic Engineering

6X01 Abrasives
6X02—Clay products
6X03—Cements, limes, plasters
6X04—Glass
6X05—Kilns, furnaces
6X06—Protective and refractory coatings for metals
6X07—Refractories
6X09—Other (specify)

Chemical Engineering

6001—Adsorption and absorption
6002—Chemical separation
6003—Electrochemical operations
6004—Fluid flow
6005—Heat transfer
6006—Mass transfer
6007—Materials handling
6008—Measurement and control
6010—Mechanical separation
6011—Mixing
6012—Nuclear processes
6013—Size reduction
6009—Other (specify)

Civil Engineering

6101—Airport construction
6102—City planning
6103—Construction, heavy
6104—Construction, light
6105—Dams and stream control
6106—Highways
6107—Railroads and terminals
6108—Reclamation and water use
6110—Subways and under-city construction
6111—Waterways and harbors
6109—Other (specify)

Electrical Engineering

6201—Illumination
6202—Power generation
6203—Power transmission and distribution
6204—Rotating machinery
6205—Servomechanisms
6206—Transportation, traffic
6207—Wire communication systems
6209—Other (specify)

Engineering Mechanics

6301—Dynamics
6302—Elasticity
6303—Fluid dynamics
6304—Plasticity
6305—Properties of materials
6306—Statics
6307—Thermodynamics
6309—Other (specify)

Industrial Engineering

6401—Engineering economics
6402—Maintenance engineering
6303—Operational analysis
6404—Procurement, accounting
6405—Production engineering
6406—Production planning
6407—Quality control
6408—Standards, testing of materials
6410—Time and motion study
6409—Other (specify)

Mechanical Engineering

6501—Air conditioning
6502—Automotive engineering
6503—Boilers and steam engineering
6504—Construction
6505—Gas turbines
6506—Internal combustion engines
6507—Lubrication engineering
6508—Machine design
6510—Machine tools
6511—Materials handling
6512—Refrigeration
6513—Steam engines and turbines
6514—Textile engineering
6515—Welding engineering
6509—Other (specify)

Metallurgy and Metallurgical Engineering

6601—Electrometallurgy
6602—Foundry practice
6603—Iron and steel extraction
6604—Metal treatment & fabrication
6605—Nonferrous extraction
6606—Physical metallurgy
6607—Powder metallurgy
6608—Metallurgy, other (specify)
6609—Metallurgical engineering, other (specify)

Mining and Petroleum Engineering

6701—Benefication
6702—Open cut mining
6703—Petroleum exploration and development
6704—Petroleum production
6705—Petroleum underground storage
6706—Placer mining
6707—Underground mining
6709—Other (specify)

Sanitary Engineering

6845—Air pollution
6802—Insect and rodent control
6803—Milk and food sanitation
6804—Radiological health engineering
6805—Refuse disposal
6806—Sewage and industrial wastes
6807—Water pollution control
6808—Water supply
6809—Other (specify)

Other Engineering

6901—Agricultural engineering
6902—Architectural engineering
6903—Corrosion and preservation
6904—Fuels and combustion
6905—Human engineering
6906—Heat transfer
6907—Instrumentation and control
6908—Marine engineering
6910—Materials engineering
6911—Nuclear engineering
6912—Process engineering
6913—Product engineering
6914—Safety engineering
6909—Other (specify)

SOCIAL SCIENCES, HUMANITIES AND OTHER SPECIALTIES

Y001—Archeology
Y002—Area studies
Y003—Business administration
Y004—Business and commerce
Y005—Economics
Y006—Education
Y007—Fine and applied arts
Y008—History
Y010—History of science and mathematics
Y011—Home economics
Y012—International relations

Y013—Journalism
Y014—Law, jurisprudence
Y015—Library and archival specialty
Y016—Music
Y017—Patent law
Y018—Philosophy
Y019—Political science
Y020—Public administration
Y021—Religion and theology
Y022—Sociology
Y023—Speech
Y048—Anthropology
Y052—Scientific and technical documentation
Y062—Demography
Y074—Industrial hygiene and occupational health
Y009—Other (specify)

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Chapter V. EDUCATION AND TRAINING OF SCIENTISTS AND ENGINEERS

THE HIGHER EDUCATIONAL SYSTEM has been the training source of nearly all scientific and engineering personnel in the United States. A relatively small number of highly trained persons emigrate to this country from abroad. An additional small number in the United States achieve professional status through work experience alone—most frequently in engineering. Students who intend to become scientists and engineers must master an increasingly complex and rapidly expanding fund of scientific and engineering knowledge attained primarily through the higher educational system. Information on the entire educational system, including higher education, is presented here for a better understanding of science and technical education.

For almost a century aggregate data on the educational system have been collected and disseminated by the U.S. Office of Education. Only in the past decade, however, have sufficient data on science and technical education become available for a meaningful assessment and analysis of trends in the role of science and technical education in the educational system.

Educational data at the national level are available primarily in terms of quantity. Little is known of the quality of the training received and of the trained personnel, which are much more difficult to describe and evaluate. Nevertheless, considerable effort is being made on this problem by many organizations, and more meaningful assessments of the quality of science and technical education undoubtedly will become available within the next few years.

The data presented in this chapter are basically descriptive and deal with national aggregates. Only statistical series considered most relevant to science and technical education are included. The professional scientific and engineering staffs employed at colleges and universities, a significant number in themselves, were discussed in chapter III and will not be treated here.

The Formal Educational System

In 1961–62, the 126,000 public and private elementary and secondary schools of the United States employed teaching staffs numbering nearly 1.7 million persons and enrolled almost 45 million students. (See table V–1.) Public schools employed 86 percent of the elementary school teachers and 90 percent of the secondary school teachers. Students attending public schools accounted for 84 percent of the elementary students and 89 percent of the secondary students. More than 1 million teachers taught at the elementary school level and nearly 34 million students were enrolled in elementary grades. Approximately 2,000 institutions of higher education employed 313,000 teaching staff members and reported enrollments of almost 3.9 million students. Although one-third of these institutions were publicly supported, over half of the staff and students were at public schools.

Student Enrollments

Elementary and Secondary School Enrollments

Total student enrollments in public and private elementary and secondary schools have increased sharply during the last three decades both in actual numbers and as a proportion of school-age population. (See table V–2.) Beginning in 1949–50, elementary school enrollments rose from 22.2 million to 35 million in 1962–63; high school enrollments rose from 6.4 million to 11.7 million during the same period. The combined enrollments in elementary and secondary schools increased by more than 60 percent between 1949–50 and 1962–63. The increased holding power of the educational system is illustrated by the rise in the proportion of school-age persons actually enrolled as students, from 93.8 percent in 1949–50 to an estimated 98.7 percent in 1962–63.

TABLE V-1.—*Formal education in the United States:* [1] *institutions, teachers, and students, by level and control, 1961–62* [2]

Level	Total	Number by type of control		Public as percent of total
		Public	Private	
Institutions	128,103	107,981	20,122	84.3
Elementary	96,533	81,910	14,623	84.9
Secondary	29,530	25,350	4,180	85.8
Higher education	2,040	721	1,319	35.3
Teachers	1,988,742	1,625,254	363,488	81.7
Elementary	1,015,072	869,072	[3] 146,000	85.6
Secondary	660,983	591,983	[3] 69,000	89.5
Higher education [4]	312,687	164,199	148,488	52.5
Students	48,645,230	40,605,719	8,039,511	83.5
Elementary	33,986,000	[5] 28,686,000	[3] 5,300,000	84.4
Secondary	10,768,000	[5] 9,568,000	[3] 1,200,000	88.9
Higher education [6]	3,891,230	2,351,719	1,539,511	60.4

[1] The 50 States and the District of Columbia, except for higher education, which is aggregate United States.
[2] The latest year for which comparable figures for all systems are available.
[3] Estimated.
[4] Does not include administrative staff or faculty members engaged in research, extension, etc. Teachers are reported in terms of numbers of positions.
[5] Preliminary.
[6] Total degree-credit opening enrollment.

Sources: Public elementary and secondary institutions from unpublished data, U.S. Department of Health, Education, and Welfare, Office of Education. Higher education institutions from *Higher Education* (pt. 3 of the *Education Directory, 1961–62*). All private elementary and secondary data and data on students in higher education from *Digest of Educational Statistics, 1963*. Public elementary and secondary teachers from *Fall 1962 Enrollment, Teachers, and Schoolhousing*. Teachers in higher education from *Summary Report, Faculty and Other Professional Staff in Institutions of Higher Education, 1961–62*. Public elementary and secondary students from *Preliminary Statistics of State School Systems, 1961–62*.

TABLE V-2.—*Elementary and secondary school-year enrollments, public and private compared with school-age population, 1929–30 to 1962–63*

(Number of persons in millions)

School year	Estimated population, ages 5–17	Number of public and private enrollments			Total enrollments as percent of total population, ages 5–17	Private enrollments as percent of total enrollments
		Total	Elementary (grades K–8)	Secondary (grades 9–12)		
1962–63	47.3	46.7	35.0	11.7	98.7	14.3
1961–62	46.0	45.0	34.2	10.8	97.8	14.4
1960–61	44.7	43.9	33.8	10.1	98.2	----------
1959–60	43.8	42.0	32.4	9.6	95.9	13.6
1958–59	42.6	41.0	32.0	9.0	96.2	----------
1957–58	41.0	39.0	30.1	8.8	95.1	13.5
1956–57	39.5	37.5	29.7	7.8	94.9	----------
1955–56	38.0	36.0	28.3	7.7	94.7	13.2
1954–55	36.6	35.2	27.7	7.4	96.2	----------
1953–54	35.3	33.3	26.3	7.1	94.3	13.2
1951–52	32.3	30.5	24.0	6.6	94.4	12.6
1949–50	30.5	28.6	22.2	6.4	93.8	11.9
1939–40	30.0	28.3	21.2	7.1	94.3	9.4
1929–30	31.5	28.6	23.7	4.8	90.8	9.4

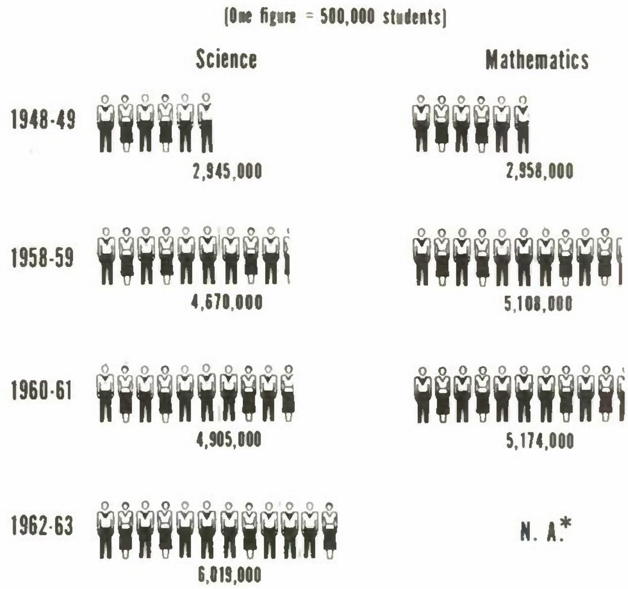
NOTE.—Detail may not add to totals because of rounding.

Sources: U.S. Department of Health, Education, and Welfare, Office of Education: January 1 population estimates for 1929–30 through 1958–59 from *Trends in Financing Public Education: 1929–30 to 1959–60;* for 1959–60 through 1962–63 from Office of Education unpublished data. Enrollments for 1929–30 to 1953–54 and for 1955–56 and 1957–58 from *Statistical Summary of Education* (ch. 1 of *Biennial Survey of Education in the United States*) for relevant years. Enrollments for 1954–55 from press release HEW-C59, 9/8/55. Enrollments for 1956–57 from "Enrollments in Elementary and Secondary Schools, Public and Private: . . . 1955–65 (estimated)," unpublished mimeographed table dated February 1957. Enrollments for 1958–59 from press release HEW-L9, 8/30/59. Enrollments for 1959–60, 1961–62, and 1962–63 and all of the last column (private as percent of total) from *Health, Education, and Welfare Trends, 1963*. Enrollments for 1960–61 from Office of Education unpublished data.

High School Enrollments in Science and Mathematics

The numbers of students enrolled in science and mathematics courses typically offered in high schools appear in table V–3. For the period selected, 1948–49 to 1962–63, the total enrollments in science courses more than doubled from less than 3 million to more than 6 million. In mathematics courses, enrollments increased from the same approximate enrollment level—less than 3 million—to more than 5 million students by 1960–61, the latest year for which these data are available. This was an increase of 75 percent (chart V–1). Increases have occurred in most science and mathematics subjects, with somewhat higher rates of increase in sophomore- and junior-year courses in science (biology and chemistry) and in junior- and senior-year courses in mathematics (intermediate algebra and trigonometry). Many of the enrollments in the "other" categories for grades 10–12 are special students chosen to participate in advanced courses, some of which give advanced standing upon college matriculation.

Chart V–1. Public high school enrollments in science and mathematics, selected years, 1948–49 to 1962–63



*Not available.

Source: Department of Health, Education, and Welfare, Office of Education.

TABLE V–3.—*Estimated total enrollments in science and mathematics courses in public high schools, selected years 1948–49 to 1962–63*

Course	Typical grade	Typical age group	Enrollments (in thousands)					
			1948–49	1954–55	1956–57	1958–59	1960–61 [1]	1962–63 [1]
Total science	9–12		2, 945	[2] 3, 460	4, 044	4, 670	4, 905	6, 019
General science	9	14	1, 074	[2] 1, 140	1, 518	1, 581	1, 549	1, 827
Biology	10	15	996	1, 294	1, 430	1, 677	1, 686	2, 487
Chemistry	11	16	412	483	520	657	708	859
Physics	12	17	291	303	310	379	385	397
Other science	10–12		172	[2] 240	266	376	577	449
Total mathematics	9–12		2, 958	[2] 3, 626	4, 401	5, 108	5, 174	(3)
General mathematics	9	14	650	800	976	1, 024	1, 377	(3)
Elementary algebra	9	14	1, 042	1, 205	1, 518	1, 775	1, 607	(3)
Plane geometry	10	15	599	664	788	979	960	(3)
Intermediate algebra	11	16	372	432	484	643	742	(3)
Trigonometry	12	17	109	170	200	220	246	(3)
Solid geometry	12	17	94	147	160	106	173	(3)
Other mathematics	10–12		92	[2] 208	275	361	69	(3)

[1] Preliminary.
[2] National Science Foundation estimates.
[3] Data not available.

Sources: U.S. Department of Health, Education, and Welfare, Office of Education: for 1962–63 from unpublished sources; for 1960–61, *Summary of Offerings and Enrollments in High School Subjects, 1960–61 (Preliminary Report)*; for 1948–49 to 1958–59 from *Offerings and Enrollments in Science and Mathematics in Public High Schools, 1958.*

Enrollments in Higher Education

The number of students enrolled in American colleges and universities increased more than fourfold between 1930 and 1964. (See table V-4.) During the early 1950's, enrollments declined slightly due to the decrease in World War II veteran enrollments and the lower birth rate of the 1930's. But for the past 10 years each year's enrollment has been larger than the last, and the 1963 enrollment is nearly double the fall 1950 enrollment.

Men have constituted about three-fifths of both total and first-time enrollments in the past few years. However, because women more frequently drop out after enrolling than men do, men are a slightly larger proportion of total enrollments than of first-time enrollments. Nevertheless, female enrollments have increased more rapidly than male enrollments since 1949-50; total female enrollments have more than doubled, while male enrollments have increased by more than three-fifths.

In 1929-30, graduate enrollments constituted less than 5 percent of all enrollments. (See table V-5.) During the decade of the 1950's, graduate enrollments increased from about 10 percent to 11 percent of total enrollments. Numerically, graduate enrollments are likely to continue increasing, although the proportion will probably not increase, because of the swelling tide of entering undergraduates. The ratio of undergraduates to the most nearly appropriate age group in the population (18-21 years) increased 2½ times during the 20 years 1939-59 and has continued to rise steadily.

Technical Training. Postsecondary educational programs of technical training which do not ordinarily lead to a bachelor's degree are an important aspect of scientific and technical training. Technical institute enrollments in engineering-related curriculums rose 87 percent between fall 1950 and fall 1960. (See table V-6). These data do not include students trained in military technician schools or those who attended inservice training programs of industrial firms. The data indicate that a significant portion of students continuing their education beyond high school graduation plan to prepare for a technical vocation rather than to complete college. Persons completing these programs often obtain employ-

TABLE V-4.—*Enrollments in institutions of higher education, total and first-time enrolled, by sex, 1929-30 to 1963-64*

(Enrollments in thousands)

Fall of academic year	Total number enrolled			Number enrolled first time			Men as percent of—	
	Total	Men	Women	Total	Men	Women	Total enrollments	First-time enrollments
1963-64	4, 529	2, 790	1, 739	1, 055	609	447	61. 6	57. 7
1962-63	4, 207	2, 603	1, 604	1, 039	602	437	61. 9	58. 0
1961-62	3, 891	2, 424	1, 467	1, 026	596	430	62. 3	58. 1
1960-61	3, 610	2, 271	1, 339	930	543	387	62. 9	58. 4
1959-60	3, 402	2. 174	1, 229	827	491	336	63. 9	59. 4
1958-59	3, 259	2, 110	1, 148	781	469	312	64. 7	60. 1
1957-58	3, 068	2, 003	1, 065	730	445	284	65. 3	61. 0
1956-57	2, 947	1, 928	1, 019	723	446	277	65. 4	61. 7
1955-56	2, 679	1, 747	931	675	418	257	65. 2	61. 9
1954-55	2, 469	1, 575	893	631	387	245	63. 8	61. 3
1953-54	2, 251	1, 432	818	572	345	227	63. 6	60. 3
1952-53	2, 148	1, 387	761	537	324	213	64. 6	60. 3
1951-52	2, 116	1, 399	718	472	280	192	66. 1	59. 3
1950-51	2, 297	1, 569	727	517	320	197	68. 3	61. 9
1949-50	2, 457	1, 728	728	558	357	201	70. 3	64. 0
1939-40	1, 365	816	549	381	228	153	59. 8	59. 8
1929-30 [1]	1, 101	620	481				56. 3	

[1] Resident degree-credit enrollment; first-time enrollment not available.

NOTE.—Detail may not add to totals because of rounding.

Sources: U.S. Department of Health, Education, and Welfare, Office of Education: for 1949-50 to 1963-64, and 1939-40, *Opening (Fall) Enrollment in Higher Education.* For 1929-30, *Statistics of Higher Education: 1955-56, Faculty, Students, and Degrees* (ch. 4, sec. 1 of *Biennial Survey of Education in the United States*).

TABLE V-5.—*Enrollments in institutions of higher education, total, undergraduate and graduate, in selected years, 1929–30 to 1963–64*

(Enrollments in thousands)

Academic year	Opening (fall) enrollments, total	Number		Graduate students as percent of total enrollments	Undergraduates per 100 persons 18–21 years on July 1
		Undergraduate enrollments	Graduate enrollments		
1963–64	4, 529	4, 049	480	[1] 10. 60	36
1962–63	4, 207	3, 761	446	[1] 10. 60	35
1961–62	3, 891	3, 479	412	[1] 10. 60	34
1960–61	3, 610	3, 227	383	[1] 10. 60	34
1959–60	3, 402	3, 042	360	10. 58	33
1958–59	3, 259	2, 915	344	[1] 10. 54	33
1957–58	3, 068	2, 746	322	10. 49	31
1956–57	2, 947	2, 653	294	[1] 9. 98	30
1955–56	2, 679	2, 425	254	9. 47	29
1954–55	2, 469	2, 216	253	[1] 10. 24	26
1953–54	2, 251	2, 003	248	11. 01	24
1952–53	2, 148	1, 921	227	[1] 10. 57	23
1951–52	2, 116	1, 902	214	10. 13	22
1950–51	2, 297	2, 078	219	[1] 9. 53	23
1949–50	2, 457	2, 238	219	8. 92	25
1939–40	1, 365	1, 269	96	7. 07	13
1929–30	1, 100	1, 053	47	4. 29	12

[1] Ratio was interpolated between adjacent years or assumed. Undergraduate and graduate enrollments were estimated from this ratio.

Sources: U.S. Department of Health, Education, and Welfare, Office of Education: for 1929–30 data, *Statistics of Higher Education, 1955–56: Faculty, Students, and Degrees* (ch. 4, sec. 1 of *Biennial Survey of Education in the United States*). For 1939–40 to 1963–64, *Opening (Fall) Enrollment in Higher Education, 1960: Analytic Report* and reports for 1962 and 1963 in this series. The percent graduate enrollment is based on biennial resident degree-credit enrollment as reported in *Statistical Summary of Education, 1957–58* (ch. 1 of *Biennial Survey of Education*). Population for the 18–21 age group from *Digest of Educational Statistics*, 1963.

ment as high-level technicians in many sectors of the economy. Some of these technically trained students continue their education after completion of the 2-year program and obtain regular baccalaureate degrees. In some instances, education obtained at these technical institutes serves as a basis for achieving professional status when combined with sufficient experience and additional advanced, job-related training.

Engineering and Science. Data for engineering enrollments portray a more irregular pattern than is true for total enrollments in all fields. (See table V–7.) In total engineering enrollments, a peak in 1957–58 was followed by a 3-year decline, then an increase for 3 consecutive years. Undergraduate engineering enrollments dipped sharply during the first half of the 1950's from a 1949–50 high of more than 200,000. This level was not reached again until the mid-1950's. Another decline in total undergraduate enrollments began

TABLE V-6.—*Enrollments in technical institutes (engineering related curriculums), 1949–50 to 1960–61*

Academic year	Total enrollments	Number enrolled—	
		Full time	Part time
1960–61	86, 780	47, 195	39, 585
1959–60	81, 061	41, 799	39, 262
1958–59	76, 112	41, 032	35, 080
1957–58	76, 307	40, 068	36, 239
1956–57	57, 622	32, 498	25, 124
1955–56	67, 163	31, 145	36, 018
1954–55	60, 747	26, 766	33, 981
1953–54	50, 937	21, 527	29, 410
1952–53	52, 737	18, 840	33, 897
1951–52	46, 417	19, 631	26, 786
1950–51	46, 441	24, 345	22, 096
1949–50	51, 746	31, 673	20, 073

Sources: For 1960–61, *Digest of Educational Statistics, 1963*. For 1956–57 to 1959–60, U.S. Department of Health, Education, and Welfare, Office of Education, *Organized Occupational Curriculums*, for the respective years and for 1949–50 to 1955–56, L. F. Smith and L. Lipsitt, *The Technical Institute*.

TABLE V-7.—*Engineering enrollments in institutions of higher education, by level, 1949-50 to 1963-64*

Academic year	Total engineering enrollments	Undergraduate		Graduate		
		Total	Freshmen	Total	Master's	Doctor's
1963-64	281,452	232,001	65,740	49,451	38,457	10,994
1962-63	275,329	230,730	64,707	44,599	35,359	9,240
1961-62	272,777	232,104	67,575	40,673	32,804	7,869
1960-61	271,850	234,190	67,556	37,660	31,215	6,445
1959-60	278,348	242,992	67,704	35,356	29,713	5,643
1958-59	289,680	256,779	70,029	32,901	28,138	4,763
1957-58	297,077	268,761	78,757	28,316	24,136	4,180
1956-57	277,052	251,121	77,738	25,931	22,529	3,402
1955-56	243,390	221,448	72,825	21,942	18,779	3,163
1954-55	214,414	193,692	65,505	20,722	17,441	3,281
1953-54	193,333	171,725	60,478	21,608	18,607	3,001
1952-53	176,549	156,080	51,631	20,469	17,539	2,930
1951-52	165,637	145,997	39,571	19,640	16,765	2,875
1950-51	180,262	161,592	34,299	18,670	15,869	2,801
1949-50	219,712	201,927	41,863	17,785	15,242	2,543

Sources: U.S. Department of Health, Education, and Welfare, Office of Education: *Engineering Enrollments and Degrees*, for respective years through 1962-63; 1963-64 from unpublished data.

in 1958-59 and, although the rates of decrease were smaller each year, the decline lasted until fall 1963. The number of entering freshmen changed little from 1959 to 1962, then registered nearly a 5-percent decline and moved up again in the fall of 1963. Opposing this undergraduate trend, graduate enrollments in engineering have continued to increase every year since 1954-55. Doctorate enrollments, in fact, have increased at a more rapid rate than enrollments for the master's degree over this period.

The junior-year majors in science, including mathematics, represent an advance measure of future bachelor's degrees in science, as do comparable data for engineering students. (See table V-8.) The apparent increase in enrollments in science and mathematics between 1957 and 1958 may be due primarily to a lower response to the initial survey in 1957 than to later surveys. Between fall 1958 and fall 1962, engineering enrollments decreased in the face of rising total junior-year enrollments. Enrollments in mathematics more than doubled (127 percent) over the period. Biological sciences increased by more than half. Much greater proportionate increases among women than among men are shown in all fields of science. Entrance of women into these fields parallels the trend for women in total enrollment.

Enrollments for advanced degrees in selected fields of science collected by the Office of Education since fall 1959, have increased in total numbers at all levels. (See table V-9.) The most marked increase—35 percent—was at the first-year level, but the intermediate- and terminal-year levels also rose—about 28 percent and 12 percent, respectively.

Part-time students made up about two-fifths of the total. Between 1959 and 1962, part-time students increased 20 percent, while full-time students increased 38 percent. The part-time student increases were entirely at the first-year level.

Total full-time students increased in every field (except "sciences, general program"). The relative increase in first-year students enrolled for an advanced degree in mathematics was greater than for any other field—57 percent. At the intermediate level, the health professions, biological sciences, and mathematics had the greatest percentage increases among full-time students. These same fields, plus physical sciences, also led in full-time terminal-year enrollment.

TABLE V–8.—*Junior-year students enrolled as majors in science and engineering, 1957–62*

Year	All fields [1]	Total science and engineering	Science					Engineering
			Total	Biological sciences	Physical sciences	Mathematics	General science program	
Fall 1957:								
Total	390, 000	98, 897	50, 513	19, 842	19, 080	9, 133	2, 458	48, 384
Men	263, 000	88, 605	40, 521	15, 317	16, 886	6, 520	1, 798	48, 084
Women	127, 000	10, 292	9, 992	4, 525	2, 194	2, 613	660	300
Fall 1958:								
Total	405, 000	102, 975	55, 777	21, 089	19, 814	11, 961	2, 913	47, 198
Men	268, 000	91, 410	44, 503	16, 350	17, 456	8, 604	2, 093	46, 907
Women	137, 000	11, 565	11, 274	4, 739	2, 358	3, 357	820	291
Fall 1959:								
Total	414, 000	101, 004	57, 265	21, 207	19, 295	14, 065	2, 698	43, 739
Men	269, 000	88, 165	44, 698	15, 955	16, 882	9, 979	1, 882	43, 467
Women	145, 000	12, 839	12, 567	5, 252	2, 413	4, 086	816	272
Fall 1960:								
Total	433, 000	102, 346	62, 213	23, 753	19, 852	15, 773	2, 835	40, 133
Men	274, 000	88, 171	48, 279	17, 806	17, 183	11, 261	2, 029	[2] 39, 892
Women	159, 000	14, 175	13, 934	5, 947	2, 669	4, 512	806	[2] 241
Fall 1962: [3]								
Total	524, 000	117, 530	76, 350	30, 977	21, 621	20, 706	3, 046	41, 180
Men	317, 000	99, 020	58, 087	23, 074	18, 625	14, 238	2, 150	[2] 40, 933
Women	207, 000	18, 510	18, 263	7, 903	2, 996	6, 468	896	[2] 247
Percent change, 1957–62:								
Total	*34. 1*	*18. 8*	*51. 1*	*56. 1*	*13. 3*	*126. 7*	*23. 9*	*−14. 9*
Men	*20. 4*	*11. 8*	*43. 4*	*50. 6*	*10. 3*	*118. 4*	*19. 6*	*−14. 9*
Women	*62. 5*	*79. 8*	*82. 8*	*74. 7*	*36. 6*	*147. 5*	*35. 8*	*−17. 7*

[1] Data rounded to nearest thousand; percent change computed from unrounded data.

[2] Estimate: Men, 99.4 percent of total; women, 0.6 percent. Men were 99.4 percent of total each year, 1957–59.

[3] No survey conducted in 1961.

Sources: Science enrollments from U.S. Department of Health, Education, and Welfare, Office of Education: for 1957 and 1958, *Junior-Year Science and Mathematics Students, Fall 1958;* and for 1959, 1960, and 1962, *Bachelor's Degrees in Science and Mathematics Expected for 1960–61* and *for 1961–62*, respectively. Engineering enrollments from *Engineering Enrollments and Degrees*, for the respective years.

TABLE V-9.—*Number of students enrolled for advanced degrees, by level in selected fields, fall 1959–62*

Year	All selected fields	Agriculture	Biological sciences	Forestry	Geography	Health professions	Mathematical subjects	Physical sciences	Psychology	Sciences, general program
	Full-time and part-time enrollments									
Total:										
1959	66,080	3,758	13,060	531	843	4,491	9,744	23,517	8,957	1,179
1960	74,752	3,852	14,775	560	1,041	5,842	11,770	25,707	10,677	528
1961	78,732	3,744	16,190	602	1,112	6,199	12,671	26,553	10,751	910
1962	85,876	4,282	17,768	713	1,281	6,586	14,121	28,591	11,344	1,190
Percent change, 1959–62	*30.0*	*13.9*	*36.0*	*34.3*	*52.0*	*46.6*	*44.9*	*21.6*	*26.6*	*.9*
First year:										
1959	32,775	1,737	6,342	272	453	2,646	5,610	10,383	4,366	966
1960	38,836	1,863	7,037	325	555	3,476	7,455	12,191	5,470	464
1961	40,502	1,783	7,699	333	656	3,496	7,851	12,245	5,655	784
1962	44,253	1,974	8,196	399	708	3,697	8,813	13,229	6,169	1,068
Percent change, 1959–62	*35.0*	*13.6*	*29.2*	*46.7*	*56.3*	*39.7*	*57.1*	*27.4*	*41.3*	*−10.6*
Intermediate year:										
1959	27,722	1,677	5,385	223	336	1,608	3,729	10,773	3,792	199
1960	29,961	1,573	6,344	214	422	2,139	3,869	11,050	4,290	60
1961	32,148	1,595	6,931	241	395	2,493	4,325	11,741	4,302	125
1962	35,348	1,952	7,919	282	516	2,681	4,806	12,672	4,403	117
Percent change, 1959–62	*27.5*	*16.4*	*47.1*	*26.5*	*53.6*	*66.7*	*28.9*	*17.6*	*16.1*	*−41.2*
Terminal year:										
1959	5,583	344	1,333	36	54	237	405	2,361	799	14
1960	5,955	416	1,394	21	64	227	446	2,466	917	4
1961	6,082	366	1,560	28	61	210	495	2,567	794	1
1962	6,275	356	1,653	32	57	208	502	2,690	772	5
Percent change, 1959–62	*12.4*	*3.5*	*24.0*	*−11.1*	*5.6*	*−12.2*	*24.0*	*13.9*	*−3.4*	*−64.3*
	Full-time enrollments									
Total:										
1959	37,232	2,354	8,513	360	546	3,040	4,157	13,245	4,511	506
1960	43,035	2,489	9,564	451	616	4,312	5,104	15,045	5,229	225
1961	46,001	2,453	10,474	444	636	4,523	5,817	15,783	5,497	374
1962	51,291	2,807	11,720	524	704	4,929	6,496	17,666	6,072	373
Percent change, 1959–62	*37.8*	*19.2*	*37.7*	*45.6*	*28.9*	*62.1*	*56.3*	*33.4*	*34.6*	*−26.3*
First year:										
1959	18,362	1,162	4,134	202	296	1,989	2,335	5,639	2,193	412
1960	21,065	1,238	4,340	274	314	2,697	2,989	6,419	2,582	212
1961	21,858	1,226	4,634	262	347	2,622	3,234	6,528	2,651	354
1962	24,022	1,306	5,084	305	354	2,842	3,494	7,288	3,014	335
Percent change, 1959–62	*30.8*	*12.4*	*23.0*	*51.0*	*19.6*	*42.9*	*49.6*	*29.2*	*37.4*	*−18.7*
Intermediate year:										
1959	15,498	999	3,491	133	214	944	1,597	6,079	1,951	90
1960	18,122	1,009	4,255	160	269	1,477	1,847	6,826	2,267	12
1961	20,112	997	4,780	163	256	1,763	2,260	7,431	2,442	20
1962	23,202	1,300	5,525	205	321	1,945	2,688	8,492	2,689	37
Percent change, 1959–62	*49.7*	*30.1*	*58.3*	*54.1*	*50.0*	*106.0*	*68.3*	*39.7*	*37.8*	*−58.9*
Terminal year:										
1959	3,372	193	888	25	36	107	225	1,527	367	4
1960	3,848	242	969	17	33	138	268	1,800	380	1
1961	4,031	230	1,060	19	33	138	323	1,824	404	0
1962	4,067	201	1,111	14	29	142	314	1,886	369	1
Percent change, 1959–62	*20.6*	*4.1*	*25.1*	*−44.0*	*−19.4*	*32.7*	*39.6*	*23.5*	*.5*	*−75.0*

Sources: U.S. Department of Health, Education, and Welfare, Office of Education: *Enrollment for Advanced Degrees, Fall 1959* and *Fall 1960*, and *Summary Report on Survey of Students Enrolled for Advanced Degrees, Fall 1961*, and *Fall 1962*.

Graduates and Degrees

Secondary School Graduates

The numbers of high school graduates nearly tripled in the period 1929–30 to 1962–63. (See table V–10.) They doubled in the first decade, between 1929–30 and 1939–40, but declined somewhat during the next 10 years to 1949–50. A year later, in 1951–52, high school graduations began a steady increase to a high of nearly 2 million in 1960–61. The low birth rate in the thirties was the major factor accounting for the decreases noted above. The continual increases following are attributable both to the growth in the school-age population and the increase in the proportion of eligible students completing high school. The latter is shown by the number of graduates per 100 persons 17 years old in the population. The number has increased over a 30-year period from 29 to an estimated 72 per 100.

Estimates of the years of science and mathematics completed by high school graduates are available for students completing school in 1957. Over 98 percent of the graduates had at least 1 year of science and 1 of mathematics. (See table V–11.) About 35 percent of all graduates had at least 2 years of mathematics; more than 35 percent had at least 2 years of science. The proportion of students completing any specific number of science courses was almost identical with the proportion completing the same number of mathematics courses.

College and University Degrees

The number of earned degrees awarded by institutions of higher education by field of study, level of degree, and sex of recipients has been ascertained for more than a decade. These data constitute a valuable index on the production of scientists and engineers.

Although the U.S. Office of Education conducts the earned degree survey annually, with few exceptions [1] it has not compiled and published the data as a statistical time series by field of study. One of the primary difficulties in making such a detailed presentation has been that the classification of fields of study has expanded threefold since the first collection of data, resulting in a

[1] U.S. Department of Health, Education, and Welfare, Office of Education, *Health, Education, and Welfare Trends, 1963;* and "Earned Degrees in Crucial Manpower Fields," *Higher Education*, March 1962.

TABLE V–10.—*High school graduates of public and private schools, by sex, in selected years, 1929–30 to 1962–63*

School year	High school graduates (in thousands)					Graduates per 100 persons 17 years old [1]
	Total	Public	Private	Boys	Girls	
1962–63 [2]	1, 980	1, 735	245	952	1, 028	72
1961–62 [2]	1, 930	1, 686	244	940	990	70
1960–61	1, 980	1, 735	245	952	1, 028	72
1959–60	1, 864	1, 627	237	898	966	66
1958–59	1, 639	1, 451	188	788	851	63
1957–58	1, 506	1, 332	174	726	780	62
1956–57	1, 458	1, 290	168	701	757	63
1955–56	1, 415	1, 252	163	680	735	61
1954–55	1, 344	1, 189	155	(3)	(3)	59
1953–54	1, 276	1, 129	147	613	664	59
1952–53	1, 198	1, 058	140	(3)	(3)	55
1951–52	1, 197	1, 056	141	569	627	56
1950–51	1, 182	1, 045	137	(3)	(3)	57
1949–50	1, 200	1, 063	136	571	629	58
1939–40	1, 221	1, 143	78	579	643	49
1929–30	667	605	62	300	367	29

[1] As of July 1, end of school year.
[2] Preliminary.
[3] Not available.

NOTE.—Detail may not add to totals because of rounding.

Sources: For data on number of graduates, U.S. Department of Health, Education, and Welfare, Office of Education: 1962–63 from unpublished data; 1961–62, 1959–60, 1957–58, 1955–56, 1953–54. 1951–52, 1949–50, 1939–40, and 1929–30 from *Health, Education, and Welfare Trends, 1963;* intermediate years are estimates based on interpolation of percents from contiguous years. Graduates per 100 persons 17 years old based on unpublished estimates from the U.S. Bureau of the Census.

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TABLE V-11.—*Percent distribution of 1957 public high school graduates, by years of high school science and mathematics courses completed and by school enrollment size* [1]

Years of subject completed	Graduates as percent completing courses in— Science: All schools	Science: Small school	Science: Medium school	Science: Large school	Mathematics: All schools	Mathematics: Small school	Mathematics: Medium school	Mathematics: Large school
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
4 or more years	14.2	12.4	14.8	15.1	14.4	9.7	15.3	17.3
3, less than 4 years	24.6	24.7	24.9	24.2	22.9	23.0	22.4	23.2
2, less than 3 years	36.9	42.3	36.3	33.0	35.2	36.5	35.1	34.3
1, less than 2 years	22.8	19.3	22.5	25.9	[2] 25.6	29.7	25.3	22.6
None	1.5	1.3	1.5	1.8	1.9	1.1	1.9	2.5

[1] Small school, fewer than 300 students; medium school, 300 to 999 students; large school, 1,000 or more.

[2] Includes 0.8 percent who had completed some but less than 1 year mathematics.

NOTE.—Detail may not add to totals because of rounding.

Source: National Education Association, Research Division, *Mathematics and Science Teaching and Facilities*, March 1959.

serious problem of comparability over the period covered by surveys. However, for many purposes such a trend series is highly desirable. The technical notes at the end of this chapter describe the categorization used in classifying degrees in this report.

Bachelor's Degrees. Natural science and engineering bachelor's degrees awarded each year between 1947–48 and 1962–63 followed the general pattern for all bachelor's degrees, i.e., rising to a high point in 1949–50, declining through 1954–55, and increasing thereafter except for a slight dip in 1960–61. (See table V-12 and chart V-2.) However, significant variations occurred in some fields. (See table V-13.) For example, the bachelor's degrees awarded in mathematics rose to a high of 6,400 in 1949–50 and declined to a low of 4,000 in 1954–55; but by 1957–58 the total number had risen to regain the losses, and by 1962–63 the total was more than 2½ times the earlier high in 1949–50. Agricultural sciences, on the other hand, show an overall decline from the high total achieved in 1949–50.

As a proportion of all bachelor's degrees awarded, natural science and engineering degrees together accounted for more than 20 percent in the 8 years to 1962–63, but among men the proportion was around 30 percent. Both total and men declined in the last 3 years of the period after a 10-year high in 1959–60. (Compare tables V-12 and V-14.) Natural sciences, total and men only, had shown a generally rising trend since 1955–56, with men at a 16-year high in 1962–63. However, engineering had declined in the proportion of all bachelor's degrees to a 16-year low in total engineering and a 9-year low for the men by 1962–63. Among "other scientific fields," there was a much smaller spread between the proportions of total and men only. They differed mainly in a somewhat higher and steadier increase for men.

The baccalaureates awarded to men indicate the male preponderance in the natural sciences and engineering. In 1962–63, nearly 86 percent of the natural sciences and engineering degrees (99 percent of the engineering degrees) were awarded to men. (Compare tables V-12 and V-14.) In "other scientific fields," however, less than 70 percent of the degrees in 1959–60 were awarded to men. In general, men tend to dominate those professional fields organized as separate schools—engineering, medicine, and dentistry. Women are more likely to graduate in scientific fields which are traditionally in the school of arts and sciences or independent liberal arts colleges. In terms of proportion in each field, women rank highest in the social sciences, then psychology, mathematics, biological sciences, and physical sciences.

TABLE V–12.—*Bachelor's and first professional degrees conferred by institutions of higher education, for all fields, natural sciences, engineering, and other scientific fields, 1947–48 to 1962–63*

Academic year	All fields [1]	Natural sciences and engineering			Other scientific fields [3]
		Total	Natural sciences [2]	Engineering	
	Number				
1962–63	450, 592	93, 656	60, 198	33, 458	91, 399
1961–62	420, 485	90, 439	55, 704	34, 735	81, 276
1960–61	401, 784	88, 393	52, 527	35, 866	74, 843
1959–60	394, 889	89, 443	51, 635	37, 808	72, 032
1958–59	385, 151	86, 474	48, 340	38, 134	68, 853
1957–58	365, 748	79, 677	44, 345	35, 332	66, 706
1956–67	340, 347	71, 594	40, 383	31, 211	61, 672
1955–56	311, 298	62, 534	36, 222	26, 312	57, 401
1954–55	287, 401	57, 066	34, 477	22, 589	52, 891
1953–54	292, 880	57, 883	35, 554	22, 329	52, 549
1952–53	304, 857	60, 834	36, 645	24, 189	52, 101
1951–52	331, 924	72, 646	42, 097	30, 549	55, 682
1950–51	384, 352	93, 793	52, 320	41, 473	63, 402
1949–50	433, 734	115, 464	63, 218	52, 246	72, 025
1948–49	366, 698	93, 715	50, 111	43, 604	58, 136
1947–48	272, 144	67, 493	36, 397	31, 096	48, 823
	Percent				
1962–63	100. 0	20. 8	13. 4	7. 4	20. 3
1961–62	100. 0	21. 5	13. 2	8. 3	14. 4
1960–61	100. 0	22. 0	13. 1	8. 9	18. 7
1959–60	100. 0	22. 7	13. 1	9. 6	18. 2
1958–59	100. 0	22. 5	12. 6	9. 9	17. 9
1957–58	100. 0	21. 8	12. 1	9. 7	18. 2
1956–57	100. 0	21. 0	11. 9	9. 2	18. 1
1955–56	100. 0	20. 1	11. 6	8. 5	18. 4
1954–55	100. 0	19. 9	12. 0	7. 9	18. 4
1953–54	100. 0	19. 8	12. 1	7. 6	17. 9
1952–53	100. 0	20. 0	12. 0	7. 9	17. 1
1951–52	100. 0	21. 9	12. 7	9. 2	16. 8
1950–51	100. 0	24. 4	13. 6	10. 8	16. 5
1949–50	100. 0	26. 6	14. 6	12. 0	16. 6
1948–49	100. 0	25. 6	13. 7	11. 9	15. 9
1947–48	100. 0	24. 8	13. 4	11. 4	17. 9

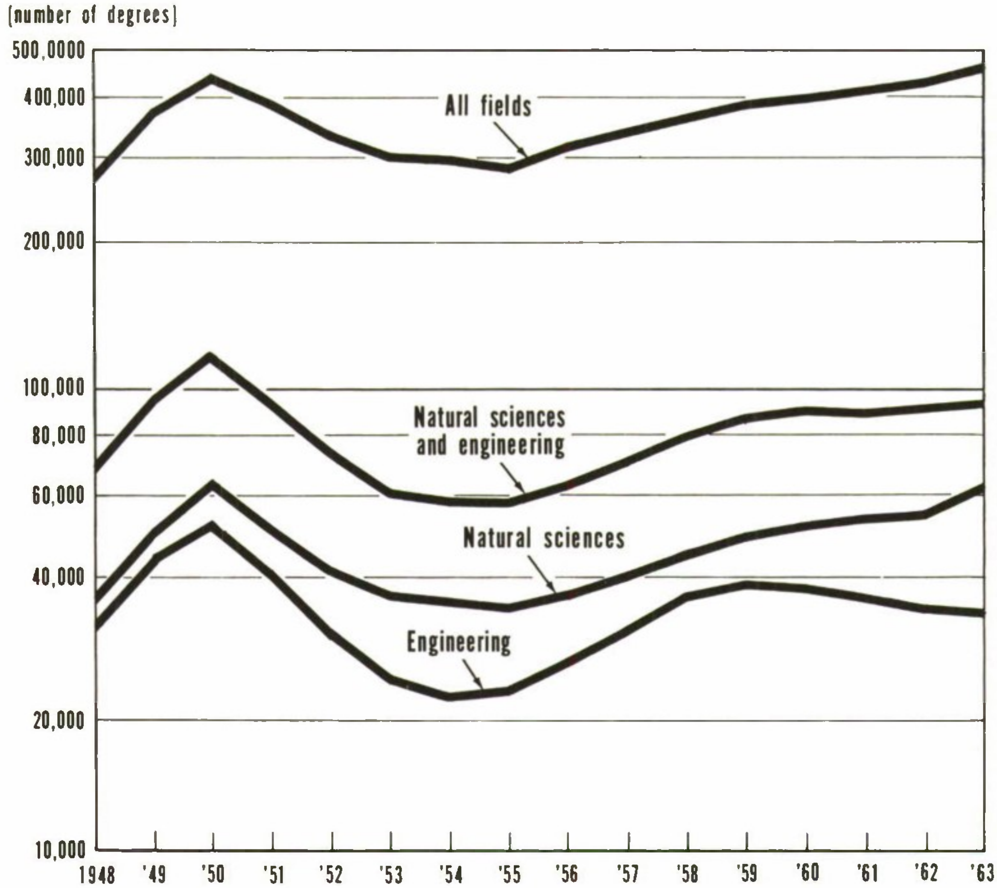
[1] Includes degrees conferred in fields other than the sciences and engineering, not shown separately.

[2] Agriculture, forestry, mathematics, biological sciences, physical sciences, and general sciences program.

[3] Psychology, geography, the social sciences, and selected health sciences (M.D., D.D.S., and D.V.M.).

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

Chart V–2. Trends in total, natural sciences, and engineering baccalaureate degrees, 1947–63



Source: Department of Health, Education, and Welfare, Office of Education.

Master's Degrees. The pattern for master's degrees is similar to that shown for bachelor's degrees, with several noteworthy differences. (See table V–15 and chart V–3.) In both total and all science and engineering master's degrees, the high point in 1950–51 was 1 year later than for bachelor's degrees and the upward trend began 1 year earlier, in 1954–55. Also, by 1958–59, the master's degrees in natural sciences and engineering had exceeded the 1950–51 high. In "other scientific fields," however, the upward trend since 1953–54 did not pass the 1950–51 peak until 1961–62. A more detailed field presentation shows characteristics similar to those found at the bachelor's level except in engineering, where the upward trend has progressed more rapidly than in other fields, passing the 1950–51 peak by 1956–57. (See table V–16.)

Among men, master's degrees received in the natural sciences and engineering made up a slightly higher proportion of all fields than shown for bachelor's degrees in recent years to 1962–63.

TABLE V-13.—*Bachelor's and first professional degrees conferred by institutions of higher education, by scientific field, 1947–48 to 1962–63*

Academic year	All sciences and engineering	Natural sciences and engineering: Total	Agricultural sciences (including forestry)	Biological sciences	Engineering	Mathematics	Physical sciences [1]	Sciences, general program	Other scientific fields: Total	Psychology	Geography	Social sciences: Basic	Social sciences: Applied	Health professions: Medicine	Health professions: Dentistry	Health professions: Veterinary
								Total								
1962-63	185, 055	93, 656	6, 063	19, 218	33, 458	16, 121	16, 276	2, 520	91, 399	11, 062	1, 122	62, 042	5, 798	7, 278	3, 191	906
1961-62	171, 715	90, 439	5, 894	17, 014	34, 735	14, 610	15, 894	2, 292	81, 276	9, 638	1, 067	54, 293	5, 053	7, 183	3, 209	833
1960-61	163, 236	88, 393	5, 717	16, 162	35, 866	13, 127	15, 500	2, 021	74, 843	8, 524	939	49, 301	4, 983	6, 986	3, 289	821
1959-60	161, 475	89, 443	6, 335	15, 655	37, 808	11, 437	16, 057	2, 151	72, 032	8, 111	973	47, 032	4, 770	7, 074	3, 247	825
1958-59	155, 327	86, 474	6, 767	15, 149	38, 134	9, 019	15, 460	1, 945	68, 853	7, 383	903	45, 107	4, 633	6, 868	3, 150	809
1957-58	146, 383	79, 677	6, 769	14, 408	35, 332	6, 924	14, 352	1, 892	66, 706	6, 930	849	43, 370	4, 786	6, 861	3, 065	845
1956-57	133, 266	71, 594	6, 619	13, 868	31, 211	5, 546	12, 934	1, 416	61, 672	6, 191	699	39, 702	4, 463	6, 785	3, 038	794
1955-56	119, 935	62, 534	6, 117	12, 566	26, 312	4, 660	11, 672	1, 207	57, 401	5, 665	651	36, 460	3, 853	6, 853	3, 009	910
1954-55	109, 957	57, 066	7, 170	9, 050	22, 589	4, 034	10, 516	3, 707	52, 891	5, 532	626	32, 399	3, 324	7, 056	3, 099	855
1953-54	110, 432	57, 883	7, 832	9, 366	22, 329	4, 090	9, 880	4, 386	52, 549	5, 758	708	31, 950	3, 471	6, 757	3, 102	803
1952-53	112, 935	60, 834	8, 825	9, 707	24, 189	4, 396	10, 414	3, 303	52, 101	5, 946	647	32, 899	2, 110	6, 686	2, 935	878
1951-52	128, 328	72, 646	9, 595	11, 196	30, 549	4, 721	12, 145	4, 440	55, 682	6, 622	669	35, 862	2, 405	6, 201	2, 918	1, 005
1950-51	157, 195	93, 793	12, 165	14, 327	41, 473	5, 753	14, 747	5, 328	63, 402	7, 819	704	42, 469	2, 694	6, 014	2, 803	899
1949-50	187, 489	115, 464	14, 999	16, 927	52, 246	6, 392	18, 220	6, 680	72, 025	9, 582	757	49, 795	2, 897	5, 612	2, 579	803
1948-49	151, 851	93, 715	10, 306	14, 106	43, 604	5, 040	14, 686	5, 973	58, 136	8, 205	511	39, 792	2, 046	5, 176	1, 765	641
1947-48	116, 316	67, 493	6, 843	12, 113	31, 096	4, 266	11, 662	1, 513	48, 823	6, 402	357	31, 584	1, 681	6, 867	1, 689	243
								Men								
1962-63 [2]	143, 462	80, 156	5, 951	13, 827	33, 328	11, 163	14, 038	1, 849	63, 306	6, 505	958	41, 298	3, 689	6, 873	3, 164	819
1961-62	136, 175	78, 443	5, 804	12, 189	34, 610	10, 355	13, 748	1, 737	57, 732	5, 817	910	37, 005	3, 208	6, 791	3, 189	812
1960-61	131, 918	77, 785	5, 647	11, 897	35, 732	9, 483	13, 492	1, 534	54, 133	5, 093	789	34, 440	3, 289	6, 448	3, 270	804
1959-60	131, 818	79, 666	6, 242	11, 693	37, 663	8, 312	14, 041	1, 715	52, 152	4, 785	858	32, 625	3, 176	6, 680	3, 221	807
1958-59	129, 102	77, 945	6, 692	11, 503	38, 013	6, 504	13, 694	1, 539	51, 157	4, 477	775	32, 382	3, 097	6, 494	3, 136	796
1957-58	121, 786	72, 258	6, 677	11, 226	35, 223	4, 953	12, 683	1, 496	49, 528	4, 063	730	30, 979	3, 395	6, 510	3, 031	820
1956-57	109, 939	64, 604	6, 465	10, 724	31, 130	3, 826	11, 321	1, 138	45, 335	3, 525	574	27, 904	3, 108	6, 432	3, 011	781
1955-56	97, 888	56, 052	6, 002	9, 607	26, 236	3, 137	10, 171	899	41, 836	3, 108	534	25, 269	2, 556	6, 498	2, 975	896
1954-55	89, 186	51, 062	7, 052	6, 519	22, 527	2, 724	9, 134	3, 106	38, 124	3, 009	496	22, 168	1, 818	6, 718	3, 071	844
1953-54	89, 131	51, 672	7, 687	6, 754	22, 264	2, 722	8, 607	3, 638	37, 459	3, 085	589	21, 682	1, 833	6, 414	3, 063	793
1952-53	92, 962	54, 771	8, 674	6, 962	24, 152	3, 122	9, 137	2, 724	38, 191	3, 330	533	22, 879	1, 331	6, 326	2, 920	872
1951-52	106, 858	66, 117	9, 451	8, 275	30, 489	3, 389	10, 813	3, 700	40, 741	3, 783	552	25, 099	1, 544	5, 871	2, 895	997
1950-51	134, 121	86, 591	12, 020	10, 716	41, 386	4, 311	13, 555	4, 603	47, 530	4, 836	583	31, 005	1, 879	5, 563	2, 768	896
1949-50	162, 167	107, 178	14, 837	13, 182	52, 071	4, 946	16, 538	5, 604	54, 989	6, 058	611	37, 940	2, 000	5, 028	2, 561	791
1948-49	126, 340	85, 266	10, 141	10, 255	43, 446	3, 513	12, 738	5, 173	41, 074	4, 591	361	28, 095	1, 164	4, 572	1, 677	614
1947-48	89, 979	58, 331	6, 644	7, 436	30, 905	2, 619	9, 454	1, 273	31, 648	2, 808	223	20, 016	630	6, 101	1, 640	230

[1] Physical sciences, general (without specific major), astronomy, chemistry, metallurgy, meteorology, physics, earth sciences, and other physical sciences.

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

TABLE V-14.—*Bachelor's and first professional degrees awarded to men by institutions of higher education, for all fields, natural sciences, engineering, and other scientific fields, 1947–48 to 1962–63*

Academic year	All fields [1]	Natural sciences and engineering: Total	Natural sciences and engineering: Natural sciences [2]	Natural sciences and engineering: Engineering	Other scientific fields [3]
	Number				
1962-63	274, 750	80, 156	46, 828	33, 328	63, 306
1961-62	262, 015	78, 443	43, 833	34, 610	57, 732
1960-61	255, 897	77, 785	42, 053	35, 732	54, 133
1959-60	255, 504	79, 666	42, 003	37, 663	52, 152
1958-59	254, 868	77, 945	39, 932	38, 013	51, 157
1957-58	242, 948	72, 258	37, 035	35, 223	49, 528
1956-57	222, 738	64, 604	33, 474	31, 130	45, 335
1955-56	199, 571	56, 052	29, 816	26, 236	41, 836
1954-55	183, 602	51, 062	28, 535	22, 527	38, 124
1953-54	187, 500	51, 672	29, 408	22, 264	37, 459
1952-53	200, 820	54, 771	30, 619	24, 152	38, 191
1951-52	227, 029	66, 117	35, 628	30, 489	40, 741
1950-51	279. 343	86, 591	45, 205	41, 386	47, 530
1949-50	329, 819	107, 178	55, 107	52, 071	54, 989
1948-49	264, 222	85, 266	41, 820	43, 446	41, 074
1947-48	175, 987	58, 331	27, 426	30, 905	31, 648
	Percent				
1962-63	100. 0	29. 2	17. 0	12. 1	23. 0
1961-62	100. 0	29. 9	16. 7	13. 2	22. 0
1960-61	100. 0	30. 4	16. 4	14. 0	21. 2
1959-60	100. 0	31. 2	16. 4	14. 7	20. 4
1958-59	100. 0	30. 6	15. 7	14. 9	20. 1
1957-58	100. 0	29. 7	15. 2	14. 5	20. 4
1956-57	100. 0	29. 0	15. 0	14. 0	20. 4
1955-56	100. 0	28. 1	14. 9	13. 1	21. 0
1954-55	100. 0	27. 8	15. 5	12. 3	20. 8
1953-54	100. 0	27. 6	15. 7	11. 9	20. 0
1952-53	100. 0	27. 3	15. 2	12. 0	19. 0
1951-52	100. 0	29. 1	15. 7	13. 4	17. 9
1950-51	100. 0	31. 0	16. 2	14. 8	17. 0
1949-50	100. 0	32. 5	16. 7	15. 8	16. 7
1948-49	100. 0	32. 2	15. 8	16. 4	15. 5
1947-48	100. 0	33. 1	15. 6	17. 6	18. 0

[1] Includes degrees conferred in fields other than the sciences and engineering, not shown separately.

[2] Agriculture, forestry, mathematics, biological sciences, physical sciences, and general sciences program.

[3] Psychology, geography, the social sciences, and selected health sciences (M.D., D.D.S., and D.V.M.).

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

TABLE V–15.—*Master's degrees conferred by institutions of higher education, for all fields, natural sciences, engineering, and other scientific fields, 1947–48 to 1962–63*

Academic year	All fields [1]	Natural sciences and engineering			Other scientific fields [3]
		Total	Natural sciences [2]	Engineering	
	Number				
1962–63	91,418	21,808	12,173	9,635	10,562
1961–62	84,889	20,190	11,281	8,909	9,393
1960–61	78,269	18,300	10,122	8,178	8,302
1959–60	74,497	16,062	8,903	7,159	7,610
1958–59	69,497	14,968	8,215	6,753	6,925
1957–58	65,614	13,235	7,447	5,788	6,578
1956–57	61,955	11,921	6,688	5,233	5,829
1955–56	59,294	11,144	6,420	4,724	5,542
1954–55	58,204	10,879	6,395	4,484	5,627
1953–54	56,823	10,291	6,087	4,204	5,515
1952–53	61,023	10,522	6,956	3,566	7,318
1951–52	63,587	12,131	8,040	4,091	7,909
1950–51	65,132	13,551	8,726	4,825	8,603
1949–50	58,219	12,812	8,316	4,496	8,253
1948–49	50,763	11,912	7,265	4,647	7,700
1947–48	42,417	9,997	5,799	4,198	7,361
	Percent				
1962–63	100.0	23.9	13.3	10.5	11.6
1961–62	100.0	23.8	13.3	10.5	11.1
1960–61	100.0	23.4	12.9	10.4	10.6
1959–60	100.0	21.6	12.0	9.6	10.2
1958–59	100.0	21.5	11.8	9.7	10.0
1957–58	100.0	20.2	11.3	8.8	10.0
1956–57	100.0	19.2	10.8	8.4	9.4
1955–56	100.0	18.8	10.8	8.0	9.3
1954–55	100.0	18.7	11.0	7.7	9.7
1953–54	100.0	18.1	10.7	7.4	9.7
1952–53	100.0	17.2	11.4	5.8	12.0
1951–52	100.0	19.1	12.6	6.4	12.4
1950–51	100.0	20.8	13.4	7.4	13.2
1949–50	100.0	22.0	14.3	7.7	14.2
1948–49	100.0	23.5	14.3	9.2	15.2
1947–48	100.0	23.6	13.7	9.9	17.4

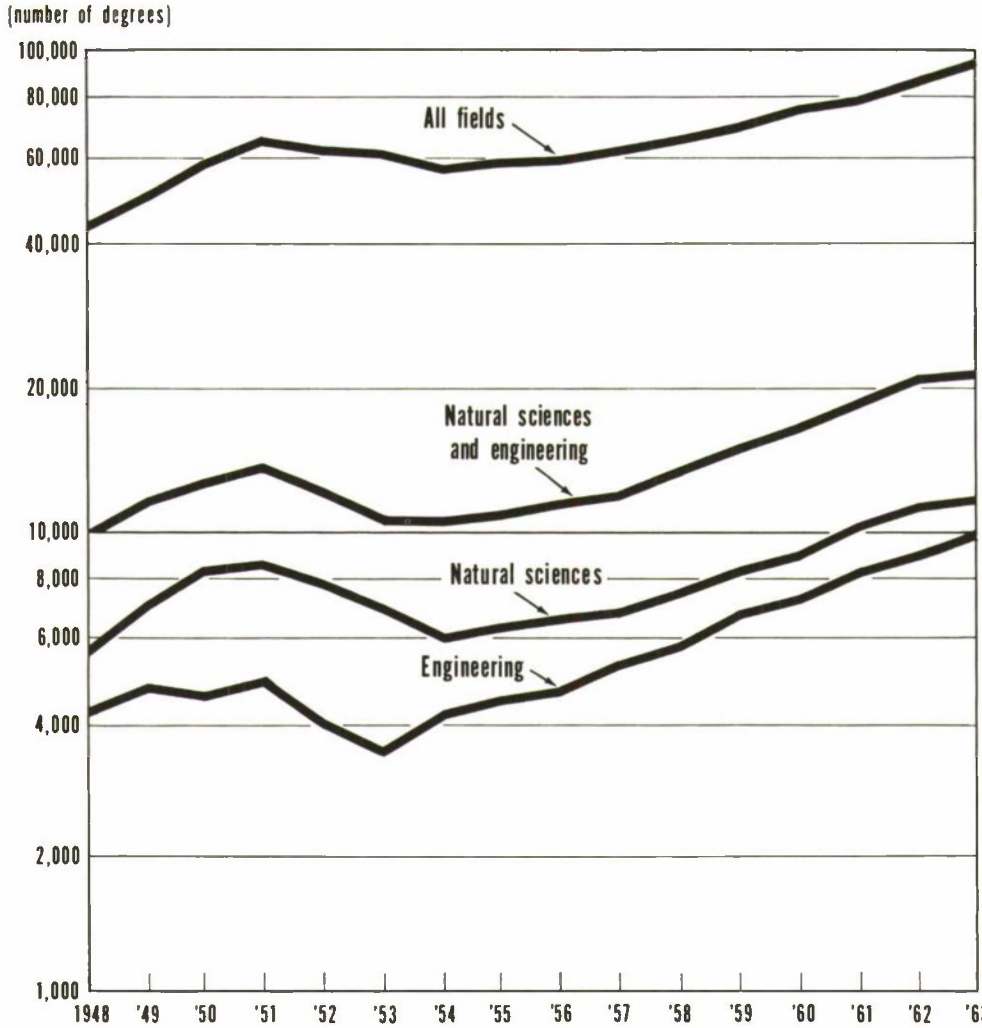
[1] Includes degrees conferred in fields other than the sciences and engineering, not shown separately.

[2] Agriculture, forestry, mathematics, biological sciences, physical sciences, and general sciences program.

[3] Geography, psychology, and social sciences; also selected health sciences (M.D., D.D.S., and D.V.M. in certain years, see table V–16).

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

Chart V–3. Trends in total, natural sciences, and engineering master's degrees, 1947–63



Source: Department of Health, Education, and Welfare, Office of Education.

(See table V–17.) In the latest year shown, engineering degrees for the first time passed natural sciences as a proportion of men in all fields, with engineering at its highest proportion in the 16-year period.

The proportion of men receiving master's degrees in the selected fields was even greater than at the bachelor's level for the 1962–63 academic year. In the natural sciences and engineering, more than 88 percent of the master's degrees were awarded to men in 1962–63. In "other scientific fields," 76 percent of the master's degrees in 1962–63 were awarded to men. Even more than at the bachelor's level, men dominate the master's degrees in fields represented by professional schools, and women tend to graduate in the scientific fields offered at schools of arts and sciences. (See table V–16.) The relative numbers of women in the social sciences, psychology, mathematics, biological sciences, and physical sciences remain about the same as those found for bachelor's degrees.

TABLE V–16.—*Master's degrees conferred by institutions of higher education, by scientific field, 1947–48 to 1962–63*

Academic year	All sciences and engineering	Natural sciences and engineering							Other scientific fields							
		Total	Agricultural sciences (including forestry)	Biological sciences	Engineering	Mathematics	Physical sciences [1]	Sciences, general program	Total	Psychology	Geography	Social sciences		Health professions		
												Basic	Applied	Medicine	Dentistry	Veterinary
Total																
1962–63	32,370	21,808	1,261	2,921	9,635	3,323	4,132	536	10,562	1,918	274	7,244	1,126	----	----	----
1961–62	29,583	20,190	1,357	2,642	8,909	2,680	3,929	673	9,393	1,832	242	6,060	1,259	----	----	----
1960–61	26,602	18,300	1,241	2,358	8,178	2,238	3,799	486	8,302	1,719	193	5,473	917	----	----	----
1959–60	23,672	16,062	1,203	2,154	7,159	1,765	3,387	394	7,610	1,406	206	5,052	946	----	----	----
1958–59	21,893	14,968	1,183	2,002	6,753	1,499	3,179	352	6,925	1,254	181	4,685	805	----	----	----
1957–58	19,813	13,235	1,104	1,852	5,188	1,234	3,034	223	6,578	1,235	184	4,292	867	----	----	----
1956–57	17,750	11,921	1,122	1,801	5,233	965	2,704	96	5,829	1,095	182	3,801	751	----	----	----
1955–56	16,686	11,144	1,038	1,759	4,724	898	2,655	70	5,542	973	161	3,586	822	----	----	----
1954–55	16,506	10,879	1,364	1,609	4,484	761	2,544	117	5,627	1,293	141	3,504	661	----	----	28
1953–54	15,806	10,291	1,302	1,610	4,204	706	2,374	95	5,515	1,254	177	3,415	653	----	----	16
1952–53	17,840	10,522	1,470	1,891	3,566	677	2,711	207	7,318	1,161	185	3,671	2,272	----	----	29
1951–52	20,040	12,131	1,608	2,307	4,091	802	3,054	269	7,909	1,406	194	3,877	2,418	----	----	14
1950–51	22,154	13,551	1,568	2,399	4,825	1,109	3,220	430	8,603	1,645	226	4,449	2,266	----	----	17
1949–50	21,065	12,812	1,505	2,209	4,496	974	3,202	426	8,253	1,316	203	4,636	2,077	----	----	21
1948–49	19,612	11,912	1,227	1,731	4,647	893	2,828	586	7,700	1,455	138	3,994	2,020	----	84	9
1947–48	17,358	9,997	1,141	1,409	4,198	711	2,509	29	7,361	1,200	157	3,854	1,781	259	92	18
Men																
1962–63	27,876	19,796	1,232	2,153	9,603	2,665	3,704	439	8,080	1,345	234	5,595	906	----	----	----
1962–61	25,627	18,479	1,321	1,982	8,869	2,179	3,544	584	7,148	1,269	212	4,610	1,057	----	----	----
1960–61	23,222	16,791	1,212	1,802	8,150	1,772	3,454	401	6,431	1,176	165	4,301	789	----	----	----
1959–60	20,720	14,799	1,190	1,668	7,133	1,428	3,060	320	5,923	981	177	3,957	808	----	----	----
1958–59	19,179	13,802	1,166	1,543	6,729	1,188	2,909	267	5,377	857	152	3,658	710	----	----	----
1957–58	17,329	12,246	1,089	1,448	5,768	994	2,763	184	5,083	836	156	3,325	766	----	----	----
1956–57	15,574	11,093	1,103	1,432	5,217	777	2,483	81	4,481	763	156	2,874	688	----	----	----
1955–56	14,582	10,320	1,021	1,379	4,705	719	2,435	61	4,262	690	129	2,776	667	----	----	----
1954–55	14,222	10,078	1,336	1,224	4,471	613	2,337	97	4,144	876	116	2,640	485	----	----	27
1953–54	13,809	9,589	1,279	1,287	4,164	579	2,197	83	4,220	885	155	2,659	506	----	----	15
1952–53	14,907	9,823	1,438	1,545	3,553	565	2,547	175	5,084	896	158	2,813	1,188	----	----	29
1951–52	16,791	11,283	1,578	1,908	4,073	663	2,830	231	5,508	1,066	159	3,024	1,246	----	----	13
1950–51	18,629	12,608	1,540	1,936	4,815	929	2,994	394	6,021	1,250	194	3,538	1,022	----	----	17
1949–50	17,347	11,808	1,492	1,738	4,481	784	2,934	379	5,539	948	150	3,606	815	----	----	20
1948–49	15,601	10,800	1,201	1,261	4,625	712	2,538	463	4,801	889	108	3,071	641	----	83	9
1947–48	13,740	9,122	1,123	999	4,189	563	2,226	22	4,618	677	113	2,915	571	233	92	17

[1] Physical sciences, general (without specific major), astronomy, chemistry, metallurgy, meteorology, physics, earth sciences, and other physical sciences.

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

TABLE V-17.—*Master's degrees awarded to men by institutions of higher education for all fields, natural sciences, engineering, and other scientific fields, 1947-48 to 1962-63*

Academic year	All fields [1]	Natural sciences and engineering: Total	Natural sciences [2]	Engineering	Other scientific fields [3]
	Number				
1962-63	62, 944	19, 796	10, 193	9, 603	8, 080
1961-62	58, 705	18, 479	9, 610	8, 869	7, 148
1960-61	54, 158	16, 791	8, 641	8, 150	6, 432
1959-60	50, 937	14, 799	7, 666	7, 133	5, 923
1958-59	47, 321	13, 802	7, 073	6, 729	5, 377
1957-58	44, 252	12, 246	6, 478	5, 768	5, 083
1956-57	41, 332	11, 093	5, 876	5, 217	4, 481
1955-56	39, 413	10, 320	5, 615	4, 705	4, 262
1954-55	38, 740	10, 078	5, 607	4, 471	4, 144
1953-54	38, 147	9, 589	5, 425	4, 164	4, 220
1952-53	40, 989	9, 823	6, 270	3, 553	5, 084
1951-52	43, 591	11, 283	7, 210	4, 073	5, 508
1950-51	46, 231	12, 608	7, 793	4, 815	6, 021
1949-50	41, 237	11, 808	7, 327	4, 481	5, 539
1948-49	35, 224	10, 800	6, 175	4, 625	4, 801
1947-48	28, 907	9, 122	4, 933	4, 189	4, 618
	Percent				
1962-63	100. 0	31. 5	16. 2	15. 3	12. 8
1961-62	100. 0	31. 5	16. 4	15. 1	12. 2
1960-61	100. 0	31. 0	16. 0	15. 0	11. 9
1959-60	100. 0	29. 1	15. 0	14. 0	11. 6
1958-59	100. 0	29. 2	14. 9	14. 2	11. 4
1957-58	100. 0	27. 7	14. 6	13. 0	11. 5
1956-57	100. 0	26. 8	14. 2	12. 6	10. 8
1955-56	100. 0	26. 2	14. 2	11. 9	10. 8
1954-55	100. 0	26. 0	14. 5	11. 5	10. 7
1953-54	100. 0	25. 1	14. 2	10. 9	11. 1
1952-53	100. 0	24. 0	15. 3	8. 7	12. 4
1951-52	100. 0	25. 9	16. 5	9. 3	12. 6
1950-51	100. 0	27. 3	16. 9	10. 4	13. 0
1949-50	100. 0	28. 6	17. 8	10. 9	13. 4
1948-49	100. 0	30. 7	17. 5	13. 1	13. 6
1947-48	100. 0	31. 6	17. 1	14. 5	16. 0

[1] Includes degrees conferred in fields other than the sciences and engineering, not shown separately.

[2] Agriculture, forestry, mathematics, biological sciences, physical sciences, and general sciences program.

[3] Geography, psychology, and social sciences, also selected health sciences (M.D., D.D.S., and D.V.M. in certain years, see table V-16).

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

Doctor's Degrees. Doctor's degrees awarded between 1947-48 and 1962-63 bear little relation to the trends occurring at the bachelor's and master's levels for the same period. (See table V-18 and chart V-4.) The annual number of all doctoral degrees, as well as all scientific and engineering degrees, increased rapidly from 1947-48 through 1949-50 and continued to increase at a slower rate through 1953-54. Between 1954-55 and 1957-58, the number of degrees awarded was

TABLE V-18.—*Doctor's degrees conferred by institutions of higher education for all fields, natural sciences, engineering, and other scientific fields, 1947–48 to 1962–63*

Academic year	All fields [1]	Natural sciences and engineering: Total	Natural sciences and engineering: Natural sciences [2]	Natural sciences and engineering: Engineering	Other scientific fields [3]
	Number				
1962–63	12,822	6,156	4,778	1,378	2,441
1961–62	11,622	5,529	4,322	1,207	2,204
1960–61	10,575	4,924	3,981	943	2,108
1959–60	9,829	4,574	3,788	786	1,946
1958–59	9,360	4,235	3,521	714	1,873
1957–58	8,942	4,014	3,367	647	1,734
1956–57	8,756	3,968	3,372	596	1,695
1955–56	8,903	3,916	3,306	610	1,804
1954–55	8,840	4,067	3,468	599	1,768
1953–54	8,996	4,135	3,541	594	1,755
1952–53	8,309	3,916	3,398	518	1,591
1951–52	7,683	3,642	3,113	529	1,541
1950–51	7,338	3,577	3,057	520	1,474
1949–50	6,633	3,108	2,691	417	1,157
1948–49	5,050	2,433	2,073	360	911
1947–48	4,188	1,847	1,590	257	654
	Percent				
1962–63	100.0	48.0	37.3	10.7	19.0
1961–62	100.0	47.6	37.2	10.4	19.0
1960–61	100.0	46.6	37.7	8.9	19.9
1959–60	100.0	46.5	38.5	8.0	19.8
1958–59	100.0	45.2	37.6	7.6	20.0
1957–58	100.0	44.9	37.7	7.2	19.4
1956–57	100.0	45.3	38.5	6.8	19.4
1955–56	100.0	44.0	37.1	6.9	20.3
1954–55	100.0	46.0	39.2	6.8	20.0
1953–54	100.0	46.0	39.4	6.6	19.5
1952–53	100.0	47.1	40.9	6.2	19.1
1951–52	100.0	47.4	40.5	6.9	20.1
1950–51	100.0	48.7	41.7	7.1	20.1
1949–50	100.0	46.9	40.6	6.3	17.4
1948–49	100.0	48.2	41.0	7.1	18.0
1947–48	100.0	44.1	38.0	6.1	15.6

[1] Includes degrees conferred in fields other than the sciences and engineering, not shown separately.

[2] Agriculture, forestry, mathematics, biological sciences, physical sciences, and general sciences program.

[3] Geography, psychology, and social sciences; also selected health fields (M.D. and D.V.M. in certain years, see table V-19).

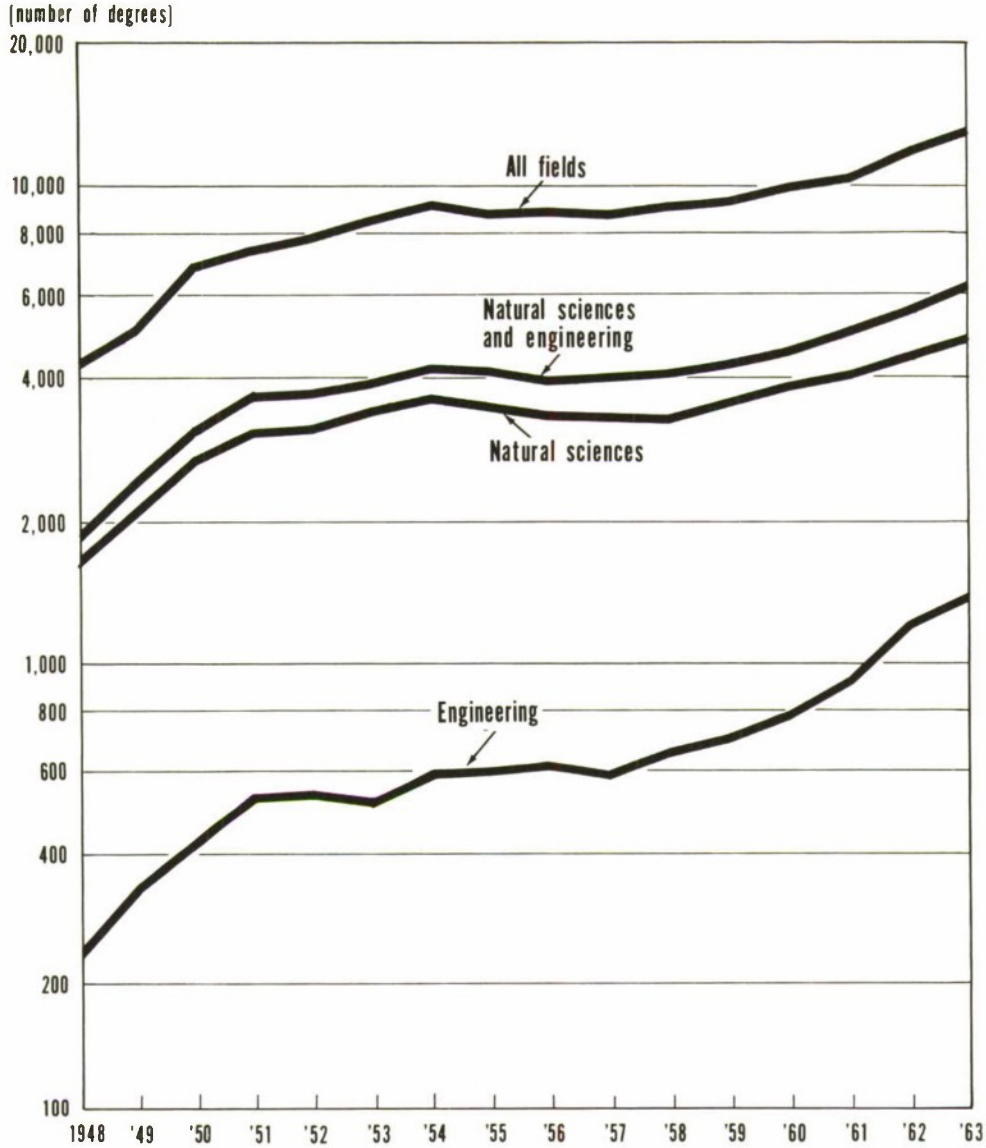
Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred* for the respective years.

fairly constant, but after 1957–58 they resumed an upward course.

During the entire period, the doctoral degrees in the natural sciences and engineering accounted for between 44 and 52 percent of the total doctoral degrees awarded in a particular year. Combining "other scientific fields" with the natural sciences and engineering, they account for between 60 and 73 percent.

Although 11 percent of all doctor's degrees awarded are obtained by women (1962–63), women were awarded only 5 percent of the degrees

Chart V-4. Trends in total, natural sciences, and engineering doctoral degrees, 1947–63



Source: Department of Health, Education, and Welfare, Office of Education.

in the natural sciences and engineering. (See table V–19.) Of the 636 doctoral degrees awarded to women in all scientific fields in 1962–63, about three-fourths were obtained in the biological and social sciences and psychology. Male doctorates show little variation from the broad fields shown for total doctoral degrees except that the proportions are slightly higher for men in the natural sciences and in engineering. (See table V–20.)

Trends. The trends in number of baccalaureates awarded vary somewhat, particularly between the natural sciences and engineering. (See chart V–2.) The trend for all bachelor's degrees is closely paralleled by the trend in natural science degrees. The trend in number of engineering degrees, for most of the period covered, appears to be amplified by the overall production, i.e., increases more rapidly with growth in numbers of degrees and decreases more as fewer degrees are awarded. The peaks and lows of bachelor's degree production are primarily attributable to the veterans and the low birth rate of the thirties, respectively.

TABLE V-19.—*Doctor's degrees conferred by institutions of higher education by scientific field, 1947-48 to 1962-63*

Academic year	All sciences and engineering	Natural sciences and engineering							Other scientific fields							
		Total	Agricultural sciences (including forestry)	Biological sciences	Engineering	Mathematics	Physical sciences [1]	Sciences, general program	Total	Psychology	Geography	Social sciences		Health professions		
												Basic	Applied	Medicine	Dentistry	Veterinary
Total																
1962-63	8,597	6,156	449	1,455	1,378	490	2,380	4	2,441	844	61	1,345	191	----	----	----
1961-62	7,733	5,529	465	1,338	1,207	396	2,122	1	2,204	781	58	1,181	184	----	----	----
1960-61	7,032	4,924	450	1,193	943	344	1,991	3	2,108	703	50	1,171	184	----	----	----
1959-60	6,520	4,574	440	1,205	786	303	1,838	2	1,946	641	68	1,118	119	----	----	----
1958-59	6,108	4,235	376	1,045	714	282	1,812	6	1,873	635	51	1,066	121	----	----	----
1957-58	5,748	4,014	340	1,125	647	247	1,655	----	1,734	572	56	994	112	----	----	----
1956-57	5,663	3,968	341	1,103	596	249	1,674	5	1,695	550	47	983	115	----	----	----
1955-56	5,720	3,916	379	1,025	610	235	1,667	----	1,804	634	46	1,011	113	----	----	----
1954-55	5,835	4,067	507	994	599	250	1,713	4	1,768	688	48	984	42	----	----	6
1953-54	5,890	4,135	515	1,077	594	227	1,686	36	1,755	619	51	1,040	37	----	----	8
1952-53	5,507	3,916	473	966	518	241	1,714	4	1,591	583	39	908	52	----	----	9
1951-52	5,183	3,642	412	764	529	206	1,720	11	1,541	540	37	901	56	----	----	7
1950-51	5,051	3,577	379	788	520	184	1,690	16	1,474	425	48	939	53	----	----	9
1949-50	4,265	3,108	368	633	417	160	1,500	30	1,157	283	40	782	44	----	----	8
1948-49	3,344	2,433	269	488	360	126	1,178	12	911	201	88	594	21	----	----	7
1947-48	2,501	1,847	191	422	257	128	849	----	654	154	17	454	9	15	----	5
Men																
1962-63	7,961	5,830	441	1,279	1,367	454	2,285	4	2,131	700	57	1,205	169	----	----	----
1961-62	7,163	5,253	463	1,179	1,203	372	2,035	1	1,910	632	54	1,061	163	----	----	----
1960-61	6,534	4,687	446	1,053	937	327	1,921	3	1,847	567	47	1,068	165	----	----	----
1959-60	6,198	4,365	433	1,086	783	285	1,776	2	1,833	544	64	1,117	108	----	----	----
1958-59	5,668	4,030	368	933	713	267	1,743	6	1,638	537	43	946	112	----	----	----
1957-58	5,330	3,785	334	987	643	232	1,589	----	1,545	488	47	904	106	----	----	----
1956-57	5,264	3,761	331	991	595	236	1,603	5	1,503	460	45	897	101	----	----	----
1955-56	5,321	3,715	373	908	610	225	1,599	----	1,606	548	43	910	105	----	----	----
1954-55	5,492	3,897	499	895	599	239	1,661	4	1,595	604	44	906	36	----	----	5
1953-54	5,536	3,949	508	977	594	213	1,625	32	1,592	553	49	945	37	----	----	8
1952-53	5,147	3,716	468	849	517	227	1,652	3	1,431	504	36	841	41	----	----	9
1951-52	4,855	3,477	402	680	526	195	1,663	11	1,378	467	36	819	50	----	----	6
1950-51	4,714	3,401	376	690	519	175	1,625	16	1,313	368	46	845	45	----	----	9
1949-50	3,981	2,954	364	543	416	151	1,451	29	1,027	241	36	702	40	----	----	8
1948-49	3,095	2,297	263	423	357	116	1,127	11	798	167	83	526	15	----	----	7
1947-48	2,276	1,716	188	345	257	118	808	----	560	122	15	399	8	11	----	5

[1] Physical sciences, agricultural (without specific major), astronomy, metallurgy, meteorology, physics, earth sciences, and other physical sciences.

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

TABLE V-20.—*Doctor's degrees awarded to men by institutions of higher education for all fields, natural sciences, engineering, and other scientific fields, 1947–48 to 1962–63*

Academic year	All fields [1]	Natural sciences and engineering: Total	Natural sciences and engineering: Natural sciences [2]	Natural sciences and engineering: Engineering	Other scientific fields [3]
	Number				
1962–63	11,448	5,830	4,463	1,367	2,131
1961–62	10,377	5,253	4,050	1,203	1,910
1960–61	9,463	4,687	3,750	937	1,847
1959–60	8,801	4,365	3,582	783	1,833
1958–59	8,371	4,030	3,317	713	1,638
1957–58	7,978	3,785	3,142	643	1,545
1956–57	7,817	3,761	3,166	595	1,503
1955–56	8,018	3,715	3,105	610	1,606
1954–55	8,014	3,897	3,298	599	1,595
1953–54	8,181	3,949	3,355	594	1,592
1952–53	7,517	3,716	3,199	517	1,431
1951–52	6,969	3,477	2,951	526	1,378
1950–51	6,664	3,401	2,882	519	1,313
1949–50	5,990	2,954	2,538	416	1,027
1948–49	4,528	2,297	1,940	357	798
1947–48	3,496	1,716	1,459	257	560
	Percent				
1962–63	100.0	49.1	41.7	7.4	16.0
1961–62	100.0	50.6	39.0	11.6	18.4
1960–61	100.0	49.5	39.6	9.9	19.5
1959–60	100.0	49.6	40.7	8.9	20.8
1958–59	100.0	48.1	39.6	8.5	19.6
1957–58	100.0	47.4	39.4	8.1	19.4
1956–57	100.0	48.1	40.5	7.6	19.2
1955–56	100.0	46.3	38.7	7.6	20.0
1954–55	100.0	48.6	41.2	7.5	19.9
1953–54	100.0	48.2	41.0	7.3	19.5
1952–53	100.0	49.4	42.6	6.9	19.0
1951–52	100.0	49.9	42.3	7.5	19.8
1950–51	100.0	51.0	43.2	7.8	19.7
1949–50	100.0	49.3	42.4	6.9	17.1
1948–49	100.0	50.7	42.9	7.9	17.6
1947–48	100.0	46.5	39.6	7.0	15.2

[1] Includes degrees conferred in fields other than the sciences and engineering, not shown separately.

[2] Agriculture, forestry, mathematics, biological sciences, physical sciences, and general sciences program.

[3] Geography, psychology, and social sciences; also selected health sciences (M.D. and D.V.M. in certain years, see table V-19).

Source: U.S. Department of Health, Education, and Welfare, Office of Education, *Earned Degrees Conferred*, for the respective years.

At the master's level, degrees both in the natural sciences and in engineering are less directly related to the total growth pattern and exhibit more independent characteristics. (See chart V–3.) The engineering curve is explainable as an increase in value in the engineering profession of the second professional degree, and the slump in the midfifties of natural science degrees may be due to the growing practice of graduate students in the natural sciences to bypass the master's

and continue directly onto the doctoral degree plus the decline in natural science bachelor's degrees.

Even less cause can be attributed at the doctoral level to the social and economic influences affecting bachelor's degree production. (See chart V–4.) The relatively large proportion that the natural sciences and engineering doctorates account for of the total Ph. D. degrees indicates that the total doctoral production is influenced more by the factors involved in producing scientists than by production of the bachelor's and master's degrees.

One generalization applicable to all degrees—by level or field of study—is that a strong cultural trend which favors the achievement of increasingly higher levels of education is becoming increasingly important. This factor will undoubtedly continue to have a strong impact on the increasing numbers of degrees awarded in all fields, including the sciences and engineering.

Retention of Students in the Educational System

The retention of students in the formal system of education until each has achieved a level of attainment commensurate with his abilities and motivation is a vital concern in insuring the Nation's supply of well-educated manpower in the sciences, engineering, and other fields of professional training. Most calculations of the dropout rate in the past have been based on aggregate enrollments in succeeding classes. The desirability of measuring the movement of a given group of students through the educational system over a period of time is receiving wider recognition. Such studies are so recent that few have been completed. For example, to measure students' retention from entry into the fifth grade in elementary school through college graduation requires more than a decade. Many of the original fifth-grade enrollees would still be in the educational system after 10 years and their eventual graduation would increase the total retention rate for the cohort (the original fifth-grade group) being measured.

Elementary and Secondary

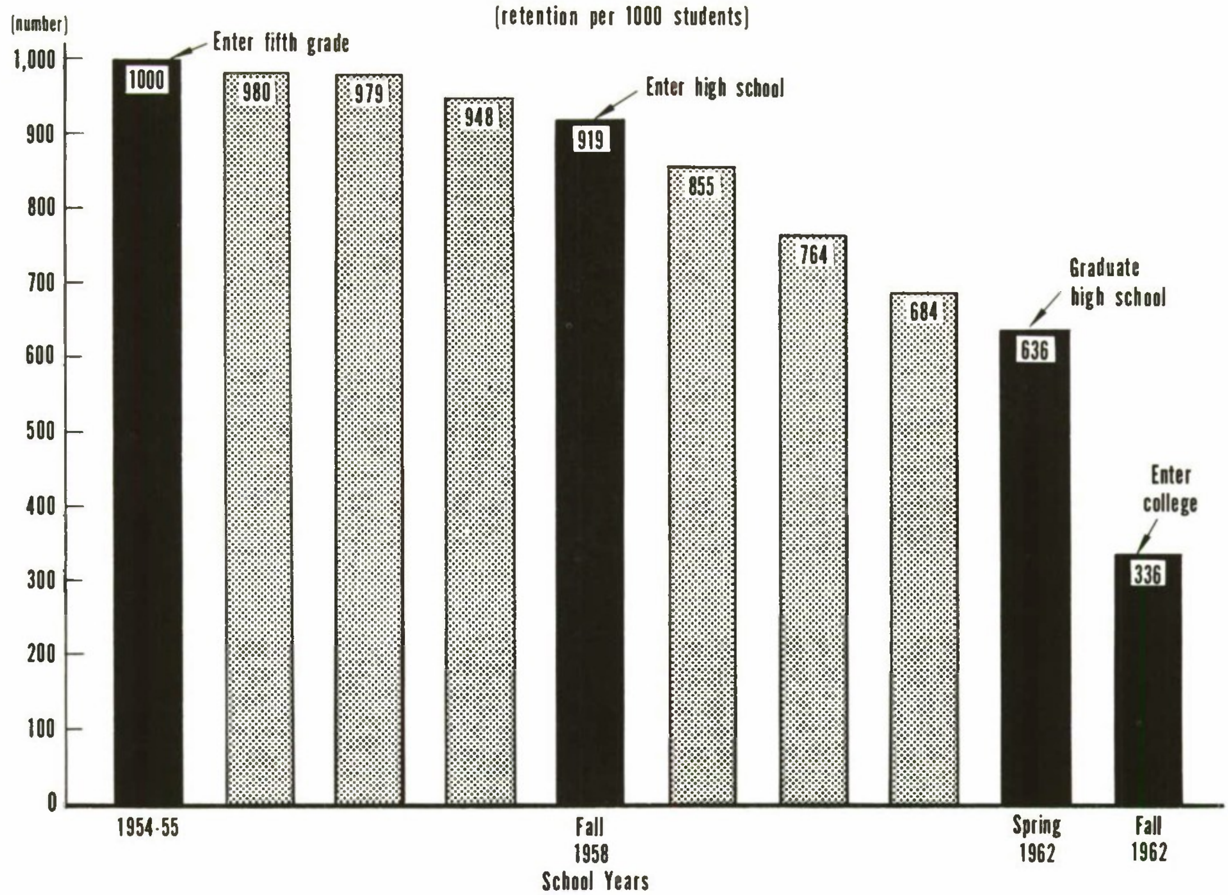
The U.S. Office of Education has maintained and published data on gross retention for about four decades. Fundamentally, this series is based on class enrollments: for example, comparing enrollments in the fifth grade in year x with enrollments in the sixth grade in year $x+1$. Data from this series for 1,000 fifth-graders enrolled in the fall of 1954 through college entrance in the fall of 1962 indicate that one-third of the fifth-grade students continued their formal education to college enrollment (chart V–5). More than 90 percent actually entered high school, but only two-thirds of the original 1,000 pupils graduated 4 years later. A sharp decline in the retention rate begins between grades 10 and 11, when students reach the maximum compulsory attendance age, and the decline continues at about the same rate to the 12th grade. Finally, these estimates indicate that over 90 percent of those who entered the 12th grade received their diplomas at the end of that school year.

Data available from the decade of the 1930's suggest that two factors—completion of grade school and attainment of age 16—had a much more significant effect on the dropout rate then than they do today. The introduction of the 6–3–3 elementary and secondary school organization has tended to smooth the dropout rate that formerly occurred at the end of the eighth grade, and cultural approval and requirements of employers for more educated personnel have motivated a greater proportion to voluntarily continue beyond the age of 16.

Undergraduate

Meaningful data on retention between college entry and graduation have many gaps. It is believed, however, that the most significant dropout rate occurs during the first 2 years, in part attributable to "washout" policies at some State universities and the achievement of a junior college certificate. The term "washout" refers to the fact that many State-supported institutions of higher education are required by law to admit any student who has received a high school diploma in the State. Often, pupils enroll who are not of college-level ability or who lack genuine motivation, and the college or university maintains a deliberate screening policy encouraging withdrawal of these students. The other factor—achievement of a 2-year college certificate—is becoming more prevalent as enrollments in community colleges increase, thereby absorbing some

Chart V–5. Retention of students in the educational system from the fifth grade through college entrance



Source: Department of Health, Education, and Welfare, Office of Education.

of the rising enrollments attributable to post-secondary-school students who are frequently satisfied to discontinue higher education after 2 years.

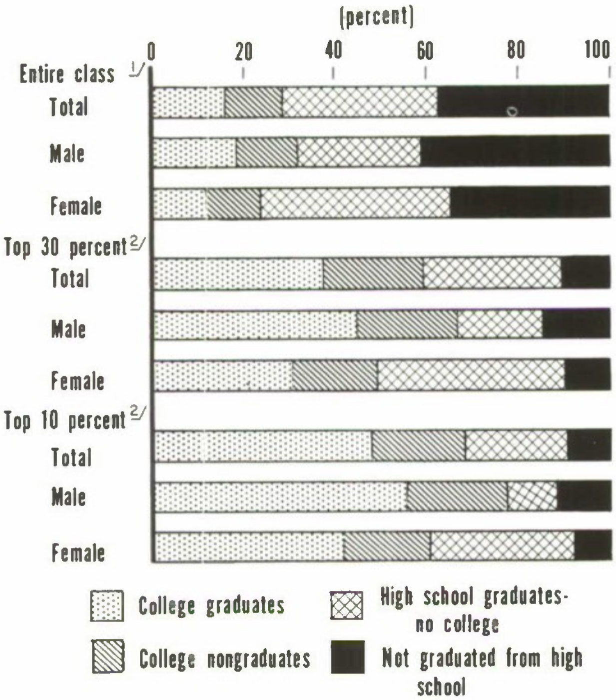
An intensive study of college entrance and graduation, based on age cohort concept, was prepared for the National Science Foundation.[2] (See chart V–6.) The age cohort selected was the 17-year-old population of July 1, 1955. Of these 17-year-olds, the study estimates that 63 percent graduated from high school and 16 percent completed requirements for a baccalaureate degree. With more than 3 million persons in each single-year age cohort for this period, a 2-percentage-point increase (14 percent compared with 16 percent) becomes significant, representing as many as 60,000 graduates. It is of even greater importance to note that the data for the top two ability levels—the top 10 percent and the top 30 percent—indicate a higher proportion of students achieving more education with each increase in the ability level. Nearly two-fifths of the highest 30 percent and around one-half of the highest 10 percent receive college degrees.

An analysis of dropouts of junior-year majors in science and mathematics in college (table V–21)

[2] National Science Foundation. *The Duration of Formal Education for High-Ability Youth*, NSF 61–36. Chart V–6 presents, for the selected age group, the estimated proportions of college graduates, full-time entrants with incomplete college training, high school graduates with no full-time college training, and those failing to graduate from high school. These percentages are compiled separately by sex and by selected ability levels.

The cumulative effect of the losses at successive stages of education amounts to 55 percent of males in the age group at the upper 30-percent ability level and to about 70 percent of the corresponding females. Nor is it much less for those in the top 10 percent in ability. At both high-ability levels, the rate of loss for males from college entrance to graduation slightly exceeds that occurring between high school graduation and college entrance, p. 4.

Chart V–6. Educational achievement of 17-year-olds



[1] 17-year-old population on July 1, 1955.
[2] Mental ability levels characteristic of top 30 percent and top 10 percent of high school graduates.
Source: National Science Foundation.

shows a stable retention rate of 79 to 82 percent for the 4-year period from 1958 to 1962. The data do not take into account the detailed reentries, holdovers, and part-time students—factors which cannot be assessed until data for a greater number of years become available. For the most recent year available, the retention rates by field range from a low of 68 percent for juniors in the preprofessional biological sciences to a high of 103 percent for those in "other physical sciences." The 103 percent does not mean that more students graduated than were originally enrolled as majors in the other physical sciences, but that some students transferred from other programs and received their degrees in one of the fields included under the "other" group.

Graduate

In the area of graduate education, a recently published study by the Bureau of Social Science Research for the National Science Foundation has provided more comprehensive and detailed information than previously available on students continuing their education beyond the undergraduate level.[3] The study indicates that about

[3] National Science Foundation, *Two Years After the College Degree*, NSF 63–26.

TABLE V–21.—*Number and ratio in selected fields of study, junior-year students and graduates in the following year*

Field of study	Junior-year students [1]				Graduates (bachelor's degrees)				Ratio of graduates to juniors in the previous year			
	Fall 1957	Fall 1958	Fall 1959	Fall 1960	1958–59	1959–60	1960–61	1961–62	Col. 5 / Col. 1	Col. 6 / Col. 2	Col. 7 / Col. 3	Col. 8 / Col. 4
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
All sciences and mathematics	50, 513	55, 777	57, 265	62, 078	41, 318	43, 870	45, 318	49, 345	0. 82	0. 79	0. 79	0. 79
Biological sciences	19, 842	21, 089	21, 207	23, 618	14, 894	15, 423	15, 961	16, 549	. 60	. 73	. 75	. 70
Premedical, predental and preveterinary sciences; and biology, general [2]	15, 671	17, 100	16, 912	18, 835	11, 131	11, 591	11, 961	12, 850	. 71	. 68	. 71	. 68
Other biological sciences [2]	4, 171	3, 989	4, 295	4, 783	3, 763	3, 832	4, 000	3, 699	. 90	. 96	. 93	. 77
Mathematical subjects	9, 133	11, 961	14, 065	15, 773	9, 019	11, 437	13, 127	14, 610	. 99	. 96	. 93	. 93
Physical sciences	19, 080	19, 814	19, 295	19, 852	15, 460	16, 057	15, 500	15, 894	. 81	. 81	. 80	. 80
Chemistry	8, 946	9, 231	9, 389	10, 135	7, 308	7, 603	7, 604	8, 086	. 82	. 82	. 81	. 80
Physics	5, 254	5, 826	6, 036	6, 438	3, 309	4, 338	4, 322	4, 812	. 72	. 74	. 72	. 75
Geology	3, 592	3, 206	2, 286	1, 736	2, 816	2, 428	1, 829	1, 404	. 78	. 76	. 80	. 81
Other physical sciences	1, 288	1, 551	1, 584	1, 543	1, 527	1, 688	1, 745	1, 592	1. 19	1. 09	1. 10	1. 03
Sciences, general program	2, 458	2, 913	2, 698	2, 835	1, 945	2, 151	2, 020	2, 292	. 79	. 74	. 75	. 81

[1] Does not include special, unclassified, extension, or correspondence students.

[2] These categories are not comparable with the categories "general biological sciences" and "other biological sciences" employed in previous reports in this series (dealing with data for fall 1957 and fall 1958). In those reports, general botany and general zoology were included in the category titled "general biological sciences." In this report general botany and general zoology are included in "other biological sciences," thus making that category approximately 40 percent larger.

Sources: U.S. Department of Health, Education, and Welfare, Office of Education. *Bachelor's Degrees in Science and Mathematics expected for 1960–61 and 1961–62;* and *Earned Degrees Conferred,* for the respective years.

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TABLE V–22.—*Graduates, by selected undergraduate field, enrolled in graduate or professional school, fall 1958 and any term to summer 1960*

Undergraduate field [1]	Number graduated, June 1958	Enrolled in graduate or professional school, any field, at least 1 term, summer 1958–summer 1960				
		Total number	Fall 1958 enrollments as percent of total			Percent enrolled other than fall 1958 [2]
			Full time	Part time	Courses only	
All fields, total	31, 999	13, 951	30. 2	10. 7	16. 5	42. 6
Men	20, 349	9, 497	37. 7	11. 7	16. 3	34. 3
Women	11, 650	4, 454	14. 2	8. 5	17. 1	60. 2
Selected fields, total	14, 313	7, 249	39. 3	11. 4	17. 2	32. 0
Men	11, 443	5, 918	43. 1	12. 0	16. 7	28. 2
Women	2, 870	1, 331	22. 6	9. 1	19. 8	48. 5
Mathematics	857	460	22. 4	13. 7	17. 4	46. 5
Men	573	328	26. 2	14. 3	18. 9	40. 6
Women	284	132	12. 9	12. 1	13. 6	61. 4
Biology and other biological sciences	1, 282	837	50. 4	7. 1	17. 4	25. 1
Men	864	632	59. 5	6. 2	13. 9	20. 4
Women	418	205	22. 4	9. 8	28. 3	39. 5
Premedical fields	399	351	78. 3	2. 1	12. 0	7. 6
Men	366	329	79. 0	2. 1	12. 5	6. 4
Women	33	22	68. 2	----------	4. 5	27. 3
Chemistry	891	527	50. 1	13. 8	19. 0	17. 1
Men	692	438	55. 7	13. 7	16. 4	14. 2
Women	199	89	22. 5	14. 6	31. 5	31. 5
Earth sciences	332	144	43. 0	8. 3	17. 4	31. 3
Men	306	132	44. 7	9. 1	17. 4	28. 8
Women	26	12	25. 0	----------	16. 7	58. 3
Physics	353	255	40. 4	15. 7	23. 5	20. 4
Men	330	239	25. 1	15. 5	23. 4	20. 1
Women	23	16	31. 3	18. 7	25. 0	25. 0
Other physical sciences	135	78	33. 3	17. 9	12. 8	35. 9
Men	135	78	33. 3	17. 9	12. 8	35. 9
Women	----------	----------	----------	----------	----------	----------
Engineering	3, 872	1, 401	22. 7	20. 2	21. 8	35. 3
Men	3, 817	1, 381	22. 9	20. 4	21. 9	34. 8
Women	55	20	10. 0	5. 0	15. 0	70. 0
Agriculture	564	184	29. 9	19. 0	14. 1	37. 0
Men	524	172	31. 4	19. 2	14. 0	35. 4
Women	40	12	8. 3	16. 7	16. 7	58. 4
Psychology	817	454	44. 9	9. 7	13. 9	31. 5
Men	486	306	52. 0	10. 8	12. 4	24. 8
Women	331	148	30. 4	7. 4	16. 9	45. 3
Social sciences	4, 811	2, 558	39. 9	7. 8	15. 3	37. 0
Men	3, 350	1, 883	46. 4	7. 7	14. 3	31. 6
Women	1, 461	675	21. 8	8. 1	18. 1	52. 0

[1] Excludes fields having less than 50 bachelor's-degree recipients.
[2] Includes those who indicated they had enrolled but did not report enrollment term.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

44 percent of all students receiving bachelor's degrees in June 1958 enrolled in graduate or professional schools before the beginning of the fall 1960 term. (See table V-22.) The proportion of students with undergraduate majors in selected science fields going on to graduate school was considerably higher—nearly 51 percent. Less than one-third of all students enrolling in graduate school in the first regular term after graduation (fall 1958) were enrolled full time, while about two-fifths of the undergraduate science majors went on to graduate school full time. Among the science fields, the highest proportion of enrollments for advanced study occurred among graduates in the premedical fields, followed by biology and chemistry; the lowest proportion was found in engineering.

A survey of 1961 college seniors substantiates the above findings and suggests that the graduates are highly motivated to obtain additional formal education. (See table V-23.) More than three-fourths planned to attend graduate or professional school at some time, and more than four-fifths indicated they would "like to attend."

Additional data from the Bureau of Social Science Research study show substantial numbers of scientists and engineers continuing their advanced training at some time in the 2 years after attaining the undergraduate degree. Nearly 16 percent of the bachelor's degree recipients in all selected science fields in 1958 were candidates for advanced degrees in summer 1960. (See table V-24.) This is in addition to the 8 percent of 1958 baccalaureate recipients who had already received a master's degree in the same or related field. About 45 percent of the degree candidates in 1960 were studying in the same field as their undergraduate degree, and another 10 percent were candidates for a related science or engineering degree. Among doctoral candidates, about 70 percent were enrolled for degrees in the same field as their undergraduate major.

There is a considerably stronger tendency for engineers to acquire advanced degrees in their undergraduate major field than there is among degree recipients in any other field. With the exception of "other physical sciences" and the social sciences, where switching of majors in graduate school is rather pronounced, one-third to one-half of the undergraduate students in each of the selected science fields were candidates for

TABLE V-23.—*Plans for graduate or professional study of June 1961 college graduates*

(In percent)

Plans of graduates	Total	Male	Female
Total	100.0	100.0	100.0
Plan to attend graduate or professional school, fall 1961	32.6	38.8	23.6
Accepted by one or more schools	20.2	25.9	11.9
Other	12.4	12.9	11.7
Plan to attend after 1961-62	44.6	41.4	49.2
Specific year given	29.9	29.7	30.2
No specific date in mind	14.7	11.7	19.0
Do not plan to attend	22.8	19.8	27.1
Yes on "If there were no obstacles . . . would you like to attend?"	5.5	6.0	4.7
Maybe or no	17.4	13.8	22.4

NOTE.—Detail may not add to totals because of rounding.

Source: National Opinion Research Center, *Great Aspirations, Career Plans of America's June 1961 College Graduates.*

advanced degrees in their undergraduate major field. It should be noted that in tables V-24 and V-22, there is no indication of how many students discontinued graduate education after attaining a master's degree in their undergraduate major.

Employment Status of Recent College Graduates

In May 1960, 75 percent of the college graduates of 1958 were employed full time or part time. More than 90 percent of all those employed were working full time. (See table V-25.) The largest number of men not in the labor force were in military service (13 percent of the total men) or were students (10 percent). Most of the women not employed were housewives. These classifications are not mutually exclusive, since a small percentage of those employed full time, and a rather substantial proportion of the graduates working part time, were also enrolled as students for graduate degrees. However, for purposes of classification, graduates who were working were

TABLE V-24.—*June 1958 bachelor's degree recipients who were candidates for advanced degrees in summer 1960, by selected field of undergraduate major and broad field of graduate specialization*

Undergraduate major	Number of 1958 bachelor's degrees	Master's degree candidates [1]: Total number	Master's: Percent distribution: Total	Same field	Education	Natural sciences and engineering	All other [3]	Doctor's degree candidates [2]: Total number	Doctor's: Percent distribution: Total	Same field	Natural sciences and engineering	Social sciences	All other [3]
Total, selected fields	[4] 13,914	1,811	100.0	45.4	22.9	9.3	22.4	379	100.0	69.5	10.5	2.1	17.9
Men	[4] 11,076	1,426	100.0	49.7	19.1	10.0	21.2	349	100.0	70.5	10.6	2.3	16.6
Women	[4] 2,838	385	100.0	29.6	36.6	7.0	26.8	30	100.0	56.7	10.0	—	33.3
Mathematics	857	156	100.0	46.2	32.0	10.3	11.5	28	100.0	78.6	3.6	—	17.8
Men	573	106	100.0	42.5	31.1	14.2	12.2	27	100.0	77.8	3.7	—	18.5
Women	284	50	100.0	54.0	34.0	2.0	10.0	1	100.0	(5)	—	—	—
Biology and other biological fields	1,282	160	100.0	33.1	21.9	27.5	17.5	43	100.0	53.5	32.6	—	13.9
Men	864	110	100.0	40.0	20.0	24.5	15.5	38	100.0	57.9	28.9	—	13.2
Women	418	50	100.0	18.0	26.0	34.0	22.0	5	100.0	(5)	(5)	—	(5)
Engineering	3,872	412	100.0	71.8	3.2	7.3	17.7	78	100.0	71.8	11.5	—	16.7
Men	3,817	408	100.0	72.5	2.7	7.4	17.4	78	100.0	71.8	11.5	—	16.7
Women	55	4	100.0	—	(5)	—	(5)	—	—	—	—	—	—
Chemistry	891	106	100.0	53.8	12.3	17.9	16.0	40	100.0	70.0	10.0	—	20.0
Men	692	87	100.0	55.2	11.5	18.4	14.9	37	100.0	70.3	10.8	—	18.9
Women	199	19	100.0	47.5	15.7	15.7	21.1	3	100.0	(5)	—	—	(5)
Earth sciences	332	46	100.0	58.7	23.9	2.2	15.2	9	100.0	(5)	—	—	(5)
Men	306	44	100.0	59.1	22.7	2.3	15.9	8	100.0	(5)	—	—	(5)
Women	26	2	100.0	(5)	(5)	—	—	1	100.0	(5)	—	—	—
Physics	353	80	100.0	57.5	10.0	20.0	12.5	37	100.0	67.6	13.5	—	18.9
Men	330	74	100.0	56.8	9.5	21.6	12.1	36	100.0	66.7	13.9	—	19.4
Women	23	6	100.0	(5)	(5)	—	(5)	1	100.0	(5)	—	—	—
Other physical sciences	135	27	100.0	11.1	22.2	55.6	11.1	2	100.0	—	(5)	(5)	—
Men	134	26	100.0	7.7	23.1	57.7	11.5	2	100.0	—	(5)	(5)	—
Women	1	1	100.0	(5)	—	—	—	—	—	—	—	—	—
Agriculture	564	51	100.0	39.3	29.4	17.6	13.7	20	100.0	70.0	10.0	10.0	10.0
Men	524	49	100.0	40.8	28.6	16.3	14.3	20	100.0	70.0	10.0	10.0	10.0
Women	40	2	100.0	—	(5)	(5)	—	—	—	—	—	—	—
Psychology	817	117	100.0	44.4	31.6	2.6	21.4	32	100.0	84.4	6.3	3.1	6.2
Men	486	77	100.0	53.2	20.8	2.6	23.4	26	100.0	84.7	7.7	3.8	3.8
Women	331	40	100.0	27.5	52.5	2.5	17.5	6	100.0	(5)	—	—	(5)
Social sciences	4,811	656	100.0	29.9	34.5	2.3	33.3	90	100.0	33.3	2.2	4.4	26.7
Men	3,350	445	100.0	32.4	32.4	2.6	32.6	77	100.0	70.1	2.6	5.2	22.1
Women	1,461	211	100.0	24.6	38.9	1.9	34.6	13	100.0	(5)	—	—	(5)

[1] Limited to candidates for 1st advanced degree.
[2] Limited to candidates for 2d advanced degree.
[3] Includes those who indicated candidacy for the degree but did not report the field of study.
[4] Total, selected fields, does not agree with that shown in table V-22 due to exclusion of premedical fields in this table.
[5] Percentages not computed in cases where the total is less than 15.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

categorized in a labor force status even though they also indicated that they were continuing their schooling. If the number of graduates who indicated they were students, as well as having another status, were added to the primarily student category, the total number of students would rise from 7.7 percent to almost 12 percent of the total.

A review of the employment status of graduates by field of study shows considerable variation. Among the men, about four-fifths of those who had majored in engineering were employed full time, compared with less than half of those whose

TABLE V-25.—*Employment status in May 1960 of June 1958 college graduates (bachelor's degree)*

(In percent)

Employment status	Total	Men	Women
Total [1]	100.0	100.0	100.0
Employed full time	68.5	67.8	69.9
Employed part time	6.2	6.6	5.6
Student	7.7	10.1	3.4
In military service	8.5	13.1	.3
Housewife	7.0	--------	19.1
Other [2]	.9	1.1	.5
No answer	1.2	1.2	1.2

[1] Total graduates numbered 32,122—20,399 men and 11,723 women.

[2] Includes unemployed, disabled, retired, ill, etc.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

undergraduate field of study was biology, other biological sciences, premedicine, or chemistry. Nearly one-fourth of the chemistry graduates reported that they were primarily students in graduate school; and, as expected, the highest proportion of these advanced students had an undergraduate premedical background. (See table V-26.) In psychology and the social sciences (except economics), more than 10 percent of the graduates were full-time students; a considerable number in psychology indicated that they were employed only part time, which probably reflected many who were also attending graduate school (chart V-7).

Of the women who graduated in 1958, about three-fifths or more from almost every field of study were employed full time 2 years later. With the exception of those who had been premedical students, the largest number from each field not employed full time classified themselves as housewives. About a third of the small number of women with a premedical background were full-time students, as were more than 10 percent of those who had majored in the biological sciences, the earth sciences, and sociology and anthropology. (See table V-27.)

TABLE V-26.—*June 1958 male college graduates, by selected field of undergraduate study and 1960 employment status*

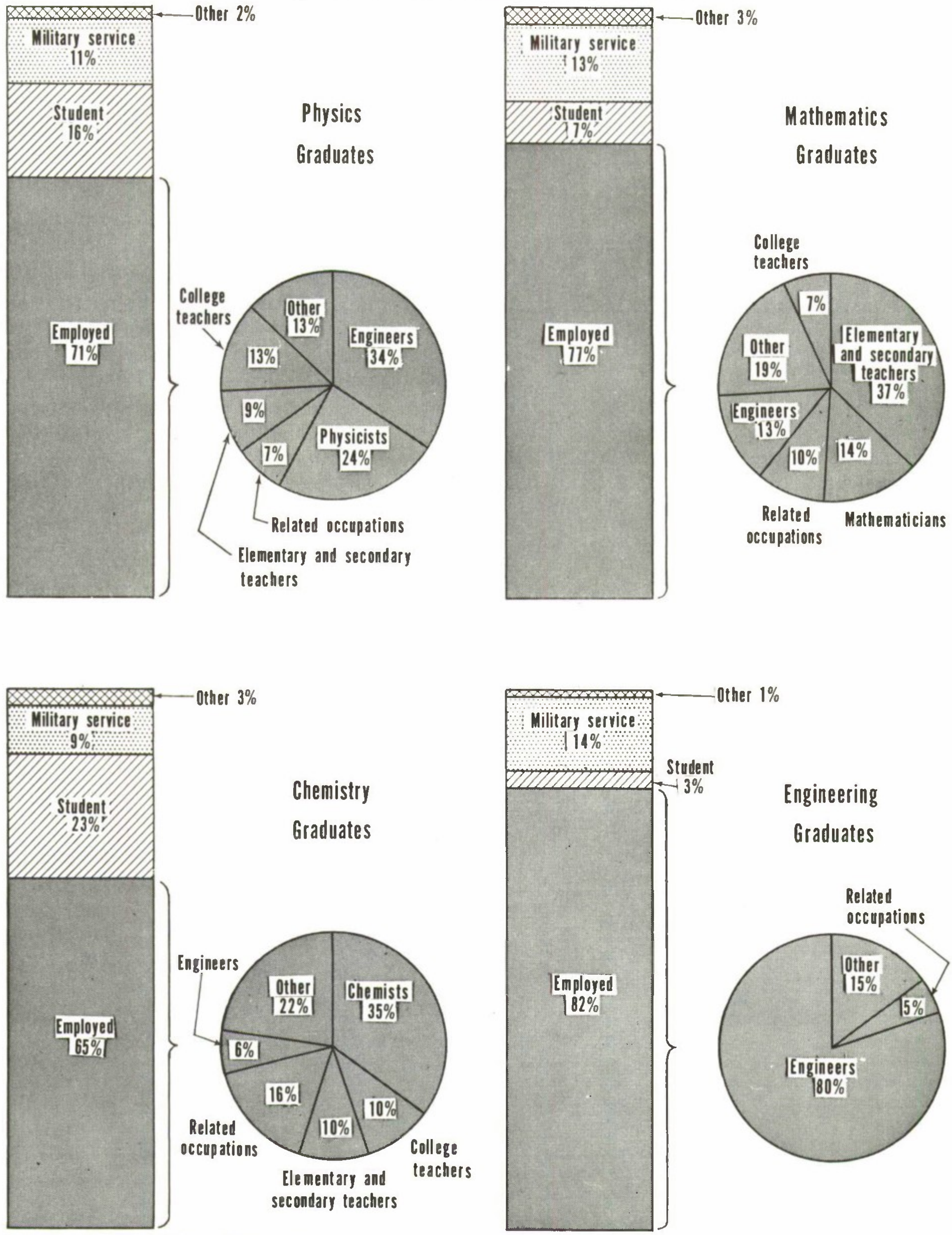
(In percent)

Undergraduate field of study	Total	Employed full time	Employed part time	Student	Military service	Other	No report
All fields [1]	100.0	67.8	6.6	10.1	13.2	1.1	1.2
Natural sciences:							
Biology	100.0	44.2	11.3	33.8	8.5	2.0	.7
Biological sciences (all other)	100.0	36.0	20.2	33.4	9.2	.9	.3
Premedicine	100.0	17.2	20.3	56.4	3.6	1.7	.8
Chemistry	100.0	47.4	17.5	22.7	9.5	1.3	1.6
Earth sciences	100.0	63.5	6.5	6.5	21.6	1.6	.3
Mathematics	100.0	69.5	7.5	6.6	13.1	.9	2.4
Physics	100.0	54.8	16.7	15.5	10.9	1.2	.9
Agriculture	100.0	68.3	7.8	5.0	16.6	.8	1.5
Physical sciences (other)	100.0	60.8	11.1	13.3	14.1	--------	.7
Engineering	100.0	79.2	2.9	3.0	13.5	.5	.9
Social sciences:							
Sociology and anthropology	100.0	59.8	11.3	15.3	9.3	3.4	.9
Economics	100.0	61.7	5.3	9.8	20.1	1.7	1.4
History	100.0	54.2	9.7	18.8	12.8	1.9	2.6
Political science	100.0	47.2	7.9	23.4	18.1	1.8	1.6
Social science (all other)	100.0	70.4	5.9	10.5	10.8	1.1	1.3
Psychology	100.0	47.7	16.0	15.7	16.5	2.7	1.4

[1] Selected fields plus all other fields in which graduates obtained degrees.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

Chart V–7. Employment status and occupation of male college graduates in selected fields, two years after the bachelor's degree, 1960



Source: National Science Foundation.

TABLE V–27.—*June 1958 female college graduates, by selected field of undergraduate study and 1960 employment status*

(In percent)

Undergraduate field of study	Total	Employed full time	Employed part time	Student	Military service	Housewife	Other	No report
All fields [1]	100.0	69.9	5.6	3.4	0.3	19.1	0.5	1.2
Natural sciences:								
Biology	100.0	67.2	7.4	6.7	----	15.7	1.1	1.9
Biological sciences (all other)	100.0	58.4	15.3	10.2	----	15.3	----	.8
Premedicine	100.0	60.6	6.1	33.3	----	----	----	----
Chemistry	100.0	69.3	9.0	5.0	----	15.7	1.0	----
Earth sciences	100.0	69.2	3.9	11.5	----	11.5	----	3.9
Mathematics	100.0	77.0	3.5	3.5	----	15.6	.4	----
Physics	100.0	56.5	17.4	8.7	----	17.4	----	----
Agriculture	100.0	72.5	2.5	2.5	2.5	20.0	----	----
Physical sciences (all other)	100.0	70.0	6.6	3.4	----	20.0	----	----
Engineering	100.0	64.0	5.5	----	1.8	26.9	----	1.8
Social sciences:								
Sociology and anthropology	100.0	57.0	7.3	10.1	.3	22.7	1.6	1.0
History	100.0	67.7	6.0	6.0	.2	18.7	.2	1.2
Economics	100.0	67.0	1.8	7.1	1.8	20.5	----	1.8
Political science	100.0	60.1	7.8	8.9	----	20.8	1.2	1.2
Social science (general)	100.0	70.6	4.7	4.9	.3	17.2	1.0	1.3
Psychology	100.0	60.3	7.2	8.1	----	22.4	.5	1.5

[1] Selected fields plus all other fields in which graduates obtained degrees.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63–26.

Relationship of Training to Occupation for Recent College Graduates

Natural Science and Engineering Majors

The survey of June 1958 college graduates sponsored by the National Science Foundation reveals, for those who majored in the natural sciences and engineering, a rather close relationship between college major and subsequent occupation in the first few years after obtaining a degree.

In 1960, about 2 years after acquiring the bachelor's degree, more than 80 percent of the almost 5,600 male science and engineering graduates who reported their occupations (in either full-time or part-time employment) held jobs that are classified as "professional" by the U.S. Bureau of the Census. Furthermore, it was found that those who had majored in engineering, the physical and life sciences, and mathematics were primarily employed in occupations directly or closely related to their field of undergraduate study. In engineering, for example, about 80 percent of the graduates were working as engineers 2 years after graduation; another 5 percent were working in other scientific occupations or as teachers of engineering, science, or mathematics. Only 24 percent of the physics majors identified themselves as physicists (chart V–7). However, many others who intended remaining in this area probably had gone on to graduate school on a full-time basis. Another 34 percent were working as engineers and over 16 percent were teaching science or mathematics in colleges and secondary schools.

There appears to be a high degree of correlation between the undergraduate training received by persons in any of the scientific fields and their occupations reported 2 years later. (See table V–28.) In addition to the specific occupations indicated, a substantial proportion of the graduates from many of the science fields were employed as research or laboratory assistants, many in fields also closely related to their major fields of study. In other cases, where there appears to be no direct relation between field of study and occupation (i.e., science or engineering graduates working as salesmen or in service and unskilled occupations), some were probably employed in part-time or temporary jobs while continuing their graduate or professional education.

TABLE V-28.—*1960 occupations of employed June 1958 male college graduates, by selected major field of study in the natural sciences, engineering, and mathematics*

Occupation	Total graduates	Agriculture	Biology	Biological sciences (all other)	Premedical	Chemistry	Earth sciences	Physics	Physical sciences (all other)	Engineering	Mathematics
Total number	5,583	399	305	176	135	449	214	236	97	3,131	441
	Percent distribution										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Teacher, college	4.0	1.8	3.3	4.6	6.7	9.8	6.0	12.7	6.2	2.1	7.1
Related subjects	3.2	.8	2.6	4.0	3.0	8.9	3.7	8.9	4.1	1.8	6.9
All other [1]	.8	1.8	.7	.6	3.7	.9	2.3	3.8	2.1	.3	.2
Teacher, secondary schools	8.8	12.3	34.7	14.1	5.1	9.4	9.8	8.4	28.9	1.1	35.6
Related subjects	7.0	6.3	29.8	11.3	4.4	7.6	6.1	7.6	25.8	.4	32.4
All other [1]	1.8	6.0	4.9	2.8	.7	1.8	3.7	.8	3.1	.7	3.2
Teacher, elementary schools	.6	1.0	3.3	-	3.0	.7	.9	.4	3.1	.1	1.4
Mathematician	1.3	-	-	-	.7	.4	.5	.8	-	.3	13.8
Programer	.4	-	-	-	-	.2	.5	1.3	1.0	.1	2.7
Statistician and actuary	.3	.3	-	-	-	-	.5	-	-	(²)	2.9
Engineer	48.4	1.7	.3	.6	.7	6.0	10.3	34.3	18.6	79.5	12.5
Agricultural scientist	2.7	27.3	3.0	7.4	-	.7	.9	.8	-	.4	.2
Biological scientist	1.2	2.2	6.9	16.5	-	.9	.5	.4	1.0	.1	-
Chemist	3.5	1.0	1.3	1.7	3.7	35.4	.9	-	3.1	.4	.7
Physical scientist, other	(²)	-	-	-	-	-	-	-	1.0	(²)	-
Earth scientist [3]	1.3	-	-	-	-	-	28.5	.4	5.1	.2	.7
Physicist	1.2	-	-	-	-	.2	-	23.7	1.0	.2	1.4
Physician in training	.4	-	1.0	.6	10.4	.7	-	-	-	(²)	-
Architect	.3	.5	-	-	-	-	-	-	-	.5	.2
Draftsman	.5	.3	.3	.6	-	-	-	-	2.1	.6	1.1
Health field, semiprofessional	1.5	2.0	6.5	5.7	14.1	3.3	.5	.4	3.1	.1	.7
Laboratory assistant	1.1	.5	3.0	5.7	1.5	5.3	2.3	1.3	1.0	.2	.2
Technician, nonmedical	.4	.5	.3	1.1	-	1.1	1.9	.4	-	.1	.5
Research assistant	4.0	6.5	5.2	14.2	11.1	10.9	2.8	6.8	8.2	1.6	2.0
Business executive or manager, or official	2.8	4.8	1.4	2.3	4.5	1.8	3.3	.8	3.1	3.0	2.5
Business or management trainee	1.8	2.2	2.6	-	2.2	1.3	3.3	.4	1.0	2.0	.2
Banking, insurance, finance official	.7	1.7	1.0	2.3	-	.2	2.8	-	1.0	.5	.2
Salesman	3.3	7.8	5.9	6.8	8.1	3.3	7.9	.4	3.1	2.1	2.5
Farmer	1.1	10.8	1.0	.6	-	-	.5	-	-	.3	.2
Service or unskilled worker	2.2	4.3	7.5	4.5	8.9	1.3	5.1	1.3	-	1.0	2.9
All others	6.0	10.5	11.5	10.7	19.3	6.9	10.3	4.7	8.2	3.4	7.7

[1] Graduates teaching subjects other than the natural sciences, mathematics, or engineering; those teaching in more than one field; and those not reporting a subject field.

[2] Less than 0.05 percent.

[3] Earth scientist, meteorologist, geophysicist, geologist, and geographer.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

Approximately 10 percent of the women who graduated in 1958 and were working 2 years later had majored in the natural sciences, mathematics, or engineering. An indication of the employment opportunities related to their fields of study for women science, mathematics, and engineering graduates is shown. (See table V-29.) Overall, about 25 percent of the women were employed as teachers of science and mathematics in secondary schools and in colleges—primarily the former. About 15 percent were employed in specified scientific occupations, and another 10 percent were working as research or laboratory assistants.

An appraisal of the occupations of women graduates and their individual fields of study reveals some interesting variations. Of the 227 mathematics majors, about 46 percent were teaching in secondary schools, and about 20 percent were employed as mathematicians (including statisticians and actuaries). A very small number indicated that they were employed as engineers. Of the 224 biology majors, more than one-fourth were employed as secondary school teachers and one-fifth in semiprofessional occupations related to the health field. Another 9 percent indicated they were either research or laboratory assistants. In both engineering and the earth sciences, most of the few women graduates were employed as elementary school teachers, although 8 of the 39 women engineering graduates were employed as engineers. Only about 3 percent of all the women graduates reported employment in secretarial, office, and clerical jobs.

TABLE V-29.—*1960 occupations of employed June 1958 female college graduates, by selected major field of study in the natural sciences, engineering, and mathematics*

Occupation	Total graduates	Agriculture	Biology	Biological sciences (all other)	Premedical	Chemistry	Earth sciences	Physics	Physical sciences (all other)	Engineering	Mathematics
Total number	844	30	224	87	22	156	19	17	23	39	227
	Percent distribution										
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Teacher, college	4.4	—	4.9	8.0	4.5	5.1	—	17.6	—	2.6	2.6
Related subjects	3.8	—	4.9	6.9	4.5	3.8	—	11.8	—	2.6	2.2
All other [1]	.6	—	—	1.1	—	1.3	—	5.8	—	—	.4
Teacher, secondary schools	25.8	6.7	28.1	10.3	—	16.0	15.8	23.5	17.4	7.7	46.4
Related subjects	21.5	3.3	21.4	8.0	—	12.2	5.3	17.6	13.1	5.1	43.3
All other [1]	4.3	3.3	6.7	2.3	—	3.8	10.5	5.9	4.3	2.6	3.1
Teacher, elementary schools	16.6	40.0	15.2	9.2	31.8	10.9	47.4	17.6	26.1	41.0	12.3
Mathematician	4.7	—	—	—	—	—	—	—	—	—	17.6
Statistician and actuary	.7	—	—	—	—	—	—	—	—	—	2.7
Programer	.8	—	—	—	—	—	—	—	—	2.6	2.6
Engineer	1.5	—	—	—	—	—	—	—	—	20.5	2.2
Biological scientist	2.2	3.3	3.6	6.9	—	1.3	—	—	8.7	—	—
Chemist	5.9	—	.9	2.3	—	26.9	—	—	13.0	2.6	—
Physical scientist, other	.6	—	—	—	—	—	—	17.6	4.3	2.6	—
Research assistant	8.1	10.0	7.1	17.3	18.2	13.5	—	5.9	—	2.6	3.1
Laboratory assistant	3.2	3.3	2.2	9.2	4.5	5.8	—	—	4.3	2.6	.4
Nurse	1.5	6.7	4.0	1.1	4.5	—	—	—	—	—	—
Health field, semiprofessional	10.8	—	21.9	24.2	9.1	8.3	—	—	8.7	2.6	1.3
Therapist	.8	—	2.7	—	—	.6	—	—	—	—	—
Technician, nonmedical	.6	—	.4	—	—	—	10.5	—	—	—	.9
Secretarial, office and clerical worker	3.2	3.3	2.7	4.6	9.2	2.6	5.3	—	—	5.1	3.1
All others	8.4	26.7	6.3	6.9	18.2	9.0	21.1	17.6	17.4	7.7	4.8

[1] Graduates teaching subjects other than the natural sciences, mathematics or engineering; those teaching in more than one field; and those not reporting a subject field.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

Psychology and Social Science Majors

For both men and women who as undergraduates majored in psychology and the social sciences, the heaviest concentration of graduates was found in teaching—primarily in secondary schools for men and in elementary schools for women. Of these men and women teachers in secondary schools, over half were teaching the various social sciences. In addition, about one-sixth of the male secondary school teachers indicated their primary teaching subjects were the natural sciences and mathematics. (See tables V-30 and V-31.)

Both men and women who majored in psychology found employment in a wide variety of occupations. By far the largest single number of women were teaching in elementary schools 2 years after obtaining their bachelor's degree. The men were dispersed over a much greater number of occupations ranging from salesmen and psychologists to business or management trainees and social and welfare workers.

TABLE V–30.—*1960 occupations of June 1958 male college graduates, by major field of study in the social sciences and psychology*

Occupation	Total graduates	Economics	History	Political science	Social sciences, miscellaneous	Sociology and anthropology	Psychology
Total number	2, 538	568	599	301	532	228	310
	Percent distribution						
Total	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0	100. 0
Teacher, college	2. 9	2. 2	2. 0	3. 3	2. 6	3. 5	5. 8
Related subjects	1. 3	1. 2	1. 2	1. 3	1. 1	2. 6	1. 3
All other [1]	1. 6	1. 0	. 8	2. 0	1. 5	. 9	4. 5
Teacher, secondary schools	21. 7	4. 7	33. 5	10. 4	43. 6	10. 9	11. 6
Related subjects	11. 7	1. 2	20. 2	7. 0	24. 8	4. 8	1. 9
Natural sciences and mathematics	3. 7	1. 6	3. 3	. 7	. 8	4. 8	5. 2
All other [1]	6. 3	1. 9	10. 0	2. 7	12. 0	1. 3	4. 5
Teacher, elementary schools	4. 1	1. 6	4. 5	4. 3	6. 8	4. 4	3. 2
Economist	1. 3	2. 5	. 2	2. 3	1. 1	----------	1. 3
Personnel worker	1. 8	2. 5	. 3	2. 0	. 8	3. 5	3. 9
Psychologist	1. 2	----------	--------	. 3	. 4	1. 3	8. 1
Social and welfare worker	4. 1	1. 0	2. 7	3. 6	3. 4	16. 2	4. 8
Clergyman	4. 0	. 4	8. 2	--------	3. 6	8. 3	4. 2
Law clerk	1. 1	. 2	1. 5	4. 0	. 8	. 4	. 3
Manager or official	3. 9	7. 4	3. 8	2. 7	1. 9	3. 1	2. 6
Business executive	2. 2	2. 8	1. 5	4. 0	1. 1	3. 1	1. 6
Business or management trainee	6. 5	11. 3	6. 0	8. 0	2. 8	3. 5	5. 8
Public official	1. 6	1. 2	1. 2	4. 3	. 9	2. 2	1. 3
Banking, finance, insurance official	4. 9	11. 6	2. 7	4. 3	3. 2	1. 8	2. 3
Accountant	1. 5	4. 0	. 5	--------	1. 3	1. 3	. 3
Statistician	. 5	1. 8	--------	. 7	----------	. 5	----------
Engineer	1. 1	2. 1	1. 2	2. 0	. 2	1. 3	1. 3
Biological scientist	. 2	. 4	. 2	. 7	----------	----------	. 3
Farmer	. 9	3. 0	. 3	--------	. 4	----------	. 3
Research assistant	2. 6	2. 6	1. 8	. 7	. 4	4. 0	9. 0
Salesman	10. 8	19. 2	6. 3	12. 6	7. 1	7. 9	10. 3
Secretarial, office, clerical worker	3. 1	2. 5	3. 7	5. 3	2. 0	2. 2	3. 6
Service or unskilled worker	4. 3	3. 0	4. 5	5. 3	3. 9	5. 7	5. 2
All others	13. 8	12. 0	13. 4	19. 2	11. 7	14. 9	12. 9

[1] Teachers of all other subjects except psychology, the social sciences, natural sciences, and mathematics; includes those not reporting a subject field.

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

Among the social sciences, men whose field of study was history or "social sciences, miscellaneous" were primarily employed as teachers. Economics majors appeared least likely to enter teaching after obtaining their undergraduate degree; about 50 percent were employed as salesmen and as officials, managers, or trainees in banking, finance, insurance, and other types of business or industry. Less than 3 percent were actually working as economists. About equal numbers of sociology and anthropology majors were employed as teachers and as social and welfare workers.

Nearly as many of the female sociology and anthropology graduates held positions in social and welfare work as in teaching. Next to teaching, women graduates in the other fields of the social sciences and psychology reported being employed in secretarial, office, and clerical positions in greater numbers than in any other occupation.

TABLE V-31.—*1960 occupations of June 1958 female college graduates, by major field of study in the social sciences and psychology*

Occupation	Total graduates	Economics	History	Political science	Social sciences, miscellaneous	Sociology and anthropology	Psychology
Total number	1,259	77	303	114	295	247	223
	Percent distribution						
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Teacher, college	1.7	----------	2.0	1.8	1.0	1.2	3.1
Related subjects	.6	----------	1.0	.9	----------	.4	.9
All other [1]	1.1	----------	1.0	.9	1.0	.8	2.2
Teacher, secondary schools	18.6	14.2	36.0	10.5	24.4	6.4	6.7
Related subjects	9.1	----------	22.8	5.2	12.2	1.6	----------
Natural sciences and mathematics	1.6	1.3	3.0	.9	1.4	1.2	.9
All other [1]	7.9	12.9	10.2	4.4	10.8	3.6	5.8
Teacher, elementary schools	28.4	29.9	24.8	16.6	40.7	20.7	31.4
Teacher, other schools [2]	1.5	1.3	1.7	1.8	1.7	.8	1.8
Social and welfare worker	9.9	----------	2.6	3.5	7.8	28.3	9.0
Social scientist	.2	----------	--------	.9	----------	.8	----------
Psychologist	1.1	----------	--------	--------	.7	1.2	4.0
Economist	.4	5.2	--------	.9	----------	----------	----------
Statistician [3]	.7	3.9	--------	.9	.7	.8	.4
Manager or official	5.1	11.7	3.6	12.3	2.4	4.0	5.8
Librarian	1.7	----------	2.6	2.6	2.0	.4	1.3
Writer	1.3	----------	2.3	2.6	.3	.8	1.3
Personnel worker	2.9	----------	.7	4.4	1.0	3.2	8.1
Research assistant	4.3	11.7	1.3	6.1	1.7	4.5	8.1
Librarian assistant	1.1	----------	2.0	1.8	.7	1.6	----------
Secretarial, office, clerical worker	13.7	15.6	15.2	24.5	10.2	13.0	10.8
Saleswoman	.6	----------	.3	--------	----------	2.0	.9
Service or unskilled worker	.9	----------	.3	1.8	.3	2.4	.4
All others	5.9	6.5	4.6	7.0	4.4	7.7	6.7

[1] Teachers of all other subjects except psychology, the social sciences, natural sciences, and mathematics; includes those not reporting a subject field.

[2] Teachers in business and commercial schools, nursery schools, art and music schools, and all others not specified.

[3] Includes one graduate classified as a "mathematician."

NOTE.—Detail may not add to totals because of rounding.

Source: National Science Foundation, *Two Years After the College Degree*, NSF 63-26.

Technical Notes

Earned Degrees Conferred

The statistical series of earned degrees comprises the most comprehensive and detailed data available on the production of highly trained personnel. Since its inception in 1947–48, however, the classification of fields has expanded nearly three times in the number of separate fields for which specific data are collected.

Obviously, such an expansion entails problems of comparability over the timespan covered by the series. The following list of fields indicates how the major scientific fields were combined for presentation in this chapter. As can be seen, the largest expansion in the classification of fields occurred in 1955–56.

Specific fields were reclassified in earlier years in order to achieve comparability of data for statistical presentation in this chapter. Further explanations appear in the footnotes after the listing of fields.

Field of science	1961–62 and 1962–63	1960–61	1955–56 through 1959–60	1951–52 through 1954–55	1947–48 through 1950–51
Natural sciences and engineering					
Agricultural sciences:					
Agronomy, field crops	X	X	X	--------	--------
Animal husbandry	X	X	X	X	X
Dairy husbandry	X	X	X	--------	--------
Dairy manufacturing, dairy technology	X	X	X	--------	--------
Farm management (excluding agricultural economics)	X	X	X	--------	--------
Fish and game, or wildlife management	X	--------	--------	--------	--------
Food technology	X	X	X	--------	--------
Horticulture (fruit and vegetable production)	X	X	X	--------	--------
Ornamental horticulture	X	X	X	--------	--------
Poultry husbandry	X	X	X	--------	--------
Soils (soil science, soil management, soil conservation)	X	X	X	--------	--------
Agriculture, other specific major fields	X	X	X	X	X
Agriculture, general (general agriculture curriculum, without major specialization)	X	X	X	--------	--------
Agriculture—not elsewhere classified	X	X	X	--------	--------
Forestry	X	X	X	X	X
Biological sciences:					
Premedical, predental, and preveterinary sciences	X	X	X	--------	--------
Biology, general	X	X	X	X	X
Botany, general	X	X	X	X	X
Zoology, general	X	X	X	X	X
Anatomy and histology	X	X	X	X	X
Bacteriology	X	X	X	X	X
Biochemistry	X	X	X	X	X
Biophysics	X	X	X	--------	--------
Cytology	X	X	--------	--------	--------
Ecology	X	--------	--------	--------	--------
Embryology	X	X	--------	--------	--------
Entomology	X	X	X	--------	--------
Genetics (including experimental plant and animal breeding)	X	X	X	--------	--------
Microbiology	X	X	--------	--------	--------
Mycology	X	X	X	--------	--------
Nutrition	X	--------	--------	--------	--------
Optometry (preprofessional bachelor's degree)	X	X	X	--------	--------
Parasitology	X	X	X	--------	--------
Pathology (except plant pathology)	X	X	X	--------	--------
Pharmacology (excluding pharmacy)	X	X	X	--------	--------
Physiology (except plant physiology)	X	X	X	--------	--------
Plant pathology	X	X	X	--------	--------
Plant physiology	X	X	X	--------	--------
Virology	X	X	X	--------	--------
Biological sciences, not elsewhere classified	X	X	X	X	(1)
Engineering [2]	X	X	X	X	X
Mathematics:					
Mathematics	X	X	X	X	X
Statistics (including actuarial science)	X	X	X	--------	--------
Sciences, general program (without major field) [3]	X	X	X	X	X

See footnotes at end of table.

Field of science	1961-62 and 1962-63	1960-61	1955-56 through 1959-60	1951-52 through 1954-55	1947-48 through 1950-51
Natural sciences and engineering—Continued					
Physical sciences:					
Physical sciences, general (without specific major)	X	X	X	--------	--------
Astronomy	X	X	X	X	X
Chemistry (excluding biochemistry)	X	X	X	X	X
Metallurgy (excluding metallurgical engineering)	X	X	X	X	X
Meteorology	X	X	X	X	X
Pharmaceutical chemistry	X	--------	--------	--------	--------
Physics	X	X	X	X	X
Earth sciences:					
Geology	X	X	X	X	X
Geophysics (including seismology)	X	X	X	--------	--------
Oceanography	X	X	X	--------	--------
Earth sciences, all other	X	X	X	--------	--------
Physical sciences, not elsewhere classified	X	X	X	X	(1)
Other scientific fields					
Psychology:					
Psychology	X	X	X	X	X
Clinical psychology	X	X	--------	--------	--------
Counseling (psychology majors)	X	X	--------	--------	--------
Social psychology	X	X	--------	--------	--------
Psychology, not elsewhere classified	X	X	--------	--------	--------
Geography	X	X	X	X	X
Social sciences, basic:					
Social sciences, general	X	X	X	--------	--------
American civilization, American culture	X	X	X	--------	--------
Anthropology	X	X	X	X	X
Area studies, regional studies	X	X	X	--------	--------
Economics (excluding agricultural economics)	X	X	X	X	X
History	X	X	X	X	X
International relations	X	X	X	X	X
Political science or Government	X	X	X	X	X
Sociology	X	X	X	X	X
Basic social sciences, not elsewhere classified [4]	X	X	X	X	X
Social sciences, applied:					
Agricultural economics	X	X	X	--------	--------
Foreign service program (consular and diplomatic service)	X	X	X	--------	--------
Industrial relations	X	X	X	--------	--------
Public administration	X	X	X	X	X
Social work, social administration	X	X	X	X	X
Applied social sciences, not elsewhere classified [4]	X	X	X	X	X
Health:					
Dentistry, D.D.S. and D.M.D. only	X	X	X	X	X
Veterinary medicine, D.V.M. only	X	X	X	X	X
Medicine, M.D. only	X	X	X	X	X

[1] Data for the years 1947-48 through 1950-51 contained the category "natural sciences, not elsewhere classified." Later classifications divided this category into "biological sciences, not elsewhere classified" and "physical sciences, not elsewhere classified." For statistical presentation in this chapter, degrees in the "natural sciences, n.e.c." were distributed at the 1951-52 ratio of "biological sciences, n.e.c." to "physical sciences, n.e.c."

[2] Engineering degrees are carried as a single-line item in the most recent years of an Office of Education series *Earned Degrees Awarded*. Detailed data for various fields of engineering, aggregating to the same total, appear in another Office of Education series, *Engineering Enrollments and Degrees*. In the earlier years of both surveys, identical totals were not always reported due to various problems of classification and accreditation. As indicated in statistical table footnotes, the *Earned Degrees* data have been used in this chapter.

[3] From 1949-50 through 1951-52 an undetermined number of degrees in military and naval science were included in sciences, general program.

[4] From 1947-48 through 1954-55 no distinction was made in the Office of Education earned degrees data between basic and applied social sciences within the category of "social sciences, not elsewhere classified." Degrees for these years were distributed in the statistical tables in this chapter between the basic and applied social sciences at the 1955-56 ratio of "basic social sciences, n.e.c." to "applied social sciences, n.e.c.".

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Chapter VI. DEMAND FOR SCIENTIFIC AND TECHNICAL PERSONNEL

KNOWLEDGE about current and future requirements for scientists, engineers, and technicians is needed in coping with the complex problems involving the utilization and training of these personnel. Such knowledge may vitally affect planning by Government, industry, and institutions of higher education for various programs which concern the national interest.

This chapter reviews some of the approaches used in obtaining indications of both short-term and long-term demand for scientists, engineers, and technicians. Statistical data are presented here only to illustrate these various methods, since the results obtained are subject to considerable change within relatively short periods of time. An exhaustive discussion of the methods and problems involved in trying to forecast the demand is not undertaken.

Effective demand, both current and future, is a many-sided phenomenon with broad dimensions. Conceptually, demand for personnel may be visualized in a number of different ways, as follows: persons currently employed in scientific and technical occupations; vacancies in established positions requiring scientific and technical personnel; needs for scientific and technical personnel recognized by employers but not formalized in the establishment of actual positions; and future needs for scientific and technical personnel presently unforeseen but implicit in the economic, social, and institutional trends currently in force. Many of these factors affect both level of demand and changes in demand which are not easily identified or measured.

Numerous questions involving demand for personnel in all economic sectors require meaningful answers for policy formulation and action programs. Some of these questions are: For what purposes and functions are scientific and technical personnel needed, and who needs them? Assuming various economic factors at work, what are the most reasonable forecasts for future needs of scientists, engineers, and technicians? How do trends in demand for such personnel relate to other economic, social, and technological trends and changes such as increase in R&D expenditures, defense-related program activities, enrollments in colleges and universities, and acceleration of automated processes in industry?

Among the specific reasons for obtaining answers to these questions, the following may be included:

Government planning for vast national defense and space programs as well as for overall economic growth must consider the need for, as well as the supply of, scientific and technical personnel. Industry must make such evaluations in planning future R&D programs and determining policies for recruitment and salaries. Institutions of higher education can plan the expansion of their facilities and staffs in a more rational manner if they are aware of the required output of scientific and technical personnel during the next decade. Such planning takes on additional urgency in view of the large expansion in college-age population beginning in the mid-1960's.

Short-Term Demand Indicators

A number of governmental and private sources are helpful in evaluating the level of current and short-run demand for scientific and technical personnel. Under present methods, however, it is impossible to obtain comprehensive quantitative information for the entire economy regarding the current demand for scientists, engineers, and technicians. This situation exists primarily because there is no mandatory centralized reporting system under which the need for such personnel as well as the number of vacancies existing in these scientific and technical occupations could be accurately estimated. Each individual source has limitations in scope and coverage, but the available sources do have some value as indicators when appraised collectively.

Certain of these indicators stem from programs or measures intended primarily for the recruitment of personnel rather than for the gathering of data

on demand for personnel. For example, information is obtained from a number of sources such as: (1) surveys of samples of employers carried out by governmental agencies, university placement offices, and private organizations to determine present and future employment of personnel; (2) job openings and applications placed with public and professional society placement services; (3) the volume of recruitment advertising placed in newspapers, magazines, and trade journals; (4) the level and trend of salaries offered beginning scientific and engineering graduates compared with college graduates from other fields.

In considering some of these sources, it should be noted that: (1) not all employers or applicants seeking jobs use public employment offices for recruitment or employment purposes; (2) college placement offices may survey only those employers who are more likely to recruit from campuses; and (3) recruitment advertising may be motivated at times by the desire to promote good will as well as by the need for personnel, and hence may be continued during periods of relatively low demand. Nevertheless, in the absence of more precise and representative measurements of short-run demand, these indicators are useful in delineating segments of the demand situation.

Although there are many private and public organizations attempting to provide clues to the current demand picture for various types of scientific and technical personnel, only a brief review of several of the better known sources are discussed below.

Bureau of Employment Security Labor Market Surveys

The Bureau of Employment Security (BES) of the U.S. Department of Labor semiannually publishes a report, *Current Labor Market Conditions in Engineering, Scientific, and Technical Occupations*, based on conditions in 30 major labor market areas throughout the United States. The information comes from statistics on job openings for selected occupations placed in interarea clearance by public employment offices throughout the country; field reports prepared by State employment security agencies affiliated with BES from which the statistics on job openings are obtained, as well as other data; and material obtained from various government agencies, professional societies, and other sources.

The primary source of data in the BES report is the *Inventory of Job Openings*, published every 2 weeks by each State employment security agency. These inventories list all openings currently in clearance (a process of matching workers in one area with jobs in other areas) by affiliated agencies. Openings in clearance are those vacancies which have not been filled locally. From these inventories, the BES, since January 1957, has been publishing reports on the number of job openings in the selected occupations covered. Since May 1958, the field offices of the 30 largest labor market areas have been furnishing supplementary data on the same occupations to give further information on the local supply-demand situations. The occupations covered include engineers, by several specialties; chemists; other natural scientists; draftsmen; and laboratory technicians and assistants. The report summarizes, by these occupations, the number of job openings in interarea clearance at public employment offices throughout the United States. It also shows separately the information by the 30 major labor market areas.[1] Recent trends in openings are also reported.

The August 1964 report showed, for example, a marked decrease of 35 percent in the overall number of job openings in these occupations from July 1963 to July 1964. (See table VI–1.) This appeared to be a continuation of the trend reported 6 months earlier (March 1964), which also showed a substantial decline. Over the year, openings for all types of engineers decreased, with aeronautical engineers showing the largest proportionate decline and electrical engineers the largest numerical decline. However, there was a slight increase in job openings for chemical, civil, and "other" engineers from May to July 1964. Vacancies for all the scientist occupations also declined substantially during the 12-month period.

Information on the numbers of applicants in the same occupations is also available. In August 1964, the number of active job applications

[1] Boston, Providence-Pawtucket, Buffalo, New York, Newark, Paterson-Clifton-Passaic, Philadelphia, Pittsburgh, Cincinnati, Cleveland, Columbus, Indianapolis, Chicago, Detroit, Milwaukee, Minneapolis-St. Paul, Kansas City, St. Louis, Baltimore, Washington (D.C.), Atlanta, Louisville, New Orleans, Dallas, Houston, Denver, Seattle, Portland, Los Angeles-Long Beach, and San Francisco-Oakland.

TABLE VI-1.—*Number of nonagricultural job openings in selected occupations in interarea clearance at public employment offices, U.S. total, 1964 and 1963*

Selected occupations	Job openings			Change to July 1964 from—			
				May 1964		July 1963	
	July 1964	May 1964	July 1963	Number	Percent	Number	Percent
Total	2, 904	3, 060	4, 481	−156	−5. 1	−1, 577	−35. 2
Engineers, total	1, 944	1, 985	3, 133	−41	−2. 1	−1, 189	−38. 0
Chemical	112	91	156	+21	+23. 1	−44	−28. 2
Civil	303	288	305	+15	+5. 2	−2	−0. 6
Electrical	533	553	1, 129	−20	−3. 6	−596	−52. 8
Industrial	211	220	283	−9	−4. 1	−72	−25. 4
Mechanical	523	546	767	−23	−4. 2	−244	−31. 8
Aeronautical	194	234	431	−40	−17. 1	−237	−55. 0
Other	68	53	62	+15	+28. 3	+6	+9. 7
Natural science occupations	298	356	471	−58	−16. 3	−173	−36. 7
Chemists	113	142	153	−29	−20. 4	−40	−26. 1
Physicists	59	79	170	−20	−25. 3	−111	−65. 3
Mathematicians	38	48	59	−10	−20. 8	−21	−35. 6
Other	88	87	89	+1	+1. 1	−1	−1. 1
Draftsmen	503	507	636	−4	−0. 8	−133	−20. 9
Laboratory technicians	159	212	241	−53	−25. 0	−82	−34. 0

Source: U.S. Department of Labor, Bureau of Employment Security, *Current Labor Market Conditions in Engineering, Scientific, and Technical Occupations August 1964.*

shown below were reported for the following three periods:

	May 1964	*November 1963*	*May 1963*
Engineers	7, 803	6, 575	7, 645
Chemists	847	820	876
Other natural scientists	1, 245	970	1, 140
Draftsmen	4, 847	4, 503	5, 904
Laboratory technicians	2, 876	3, 122	2, 766

Those figures, which show a peak in active applications in May 1963, should be considered separately from those showing interarea clearances, as they represent total applications for the selected occupations in the local employment offices of the 30 labor market areas. They indicate the applicant's availability regardless of whether he is employed or unemployed. An active employment register may reflect a number of factors relative to supply in addition to manifest availability such as dissatisfaction with current employment or a knowledge of or belief in new opportunities due to an expansion of activities by employers. Thus, the figures can be interpreted only along with other economic factors. In this case, the report indicates that there was some reduced economic activity in 1962 and mid-1963 affecting the employment of engineers and scientists.

Engineers Joint Council, Engineering Manpower Commission

The Engineering Manpower Commission (EMC) has conducted a number of surveys since 1951 on demand for college graduates of engineering curricula in industry and government. In recent years, the surveys have also covered demand for physical scientists and technicians. A recently published report, entitled *Demand for Engineers, Physical Scientists, and Technicians—1964*, was based on the mail questionnaire survey of employers taken during the latter half of 1963. It covered a substantial segment of industry and, to a lesser extent government, together employing about 252,300 engineers, 48,500 physical sci-

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entists, and 64,700 technicians. In this survey, the employers were asked to give information on engineer, physical scientist, and technician employment and recruitment; recruiting results for the previous year; expected employment of new graduates and of nongraduates for the current year; and projected short- and long-term employment needs for several selected years ahead.

Data from the report of the 1964 survey show employers' recruitment goals for engineers, physical scientists, and technicians for 1963 and 1964, as well as numbers actually hired in 1963. (See table VI-2.) According to the survey results, the total number of engineers hired by these selected employers in 1963 was only 1.5 percent less than the recruitment goals, due to the employers' ability to obtain more experienced graduate engineers and nongraduates to make up for the gap in new graduates. Recruitment goals for 1964 indicated a 7-percent decrease, compared with the total for 1963, but only a 1-percent decrease for new graduates (the goals for new engineering graduates with advanced degrees actually showing an increase). In this, as in other surveys, it appears that employers' expectations for obtaining new engineering graduates tend somewhat higher than the actual market situation warrants as shown by the numbers actually hired a year later.

Employer expectations of the short-term growth in employment of engineers and physical scientists appear to have declined somewhat from recent years. (See table VI-3.) In the engineering group, there was an anticipated average annual increase of nearly 3 percent in the 2-year period between 1963 and 1965, compared with 4 percent between 1962 and 1963. Although the 1965 estimate may be a desirable level in terms of employer requirements, experience indicates that the number actually employed often falls short of this goal.

Midwest College Placement Association Annual College Recruiting Survey

The Midwest College Placement Association, one of 8 regional groups associated with the College Placement Council, Inc., annually conducts a recruiting survey among over 400 business, government, and industrial organizations comprising the MCPA membership. The report on the survey results is published each year in the

TABLE VI-2.—*Recruitment of engineers, physical scientists, and technicians, by selected employers in industry and government: goals, 1963 and 1964, and numbers actually hired, 1963*

Occupation and recruitment source	1963		1964	Percent change in recruitment goals
	Recruitment goals	Actually hired	Recruitment goals	
Engineers	30, 891	30, 437	28, 695	−7. 1
Current class graduates	13, 360	11, 050	13, 228	−1. 0
Experienced graduates	14, 730	15, 617	13, 159	−10. 7
Nongraduates	2, 801	3, 770	2, 308	−17. 6
Physical scientists	6, 182	6, 281	5, 725	−7. 4
Current class graduates	3, 062	2, 768	3, 152	2. 9
Experienced graduates	3, 120	3, 513	2, 573	−17. 5
Technicians	10, 114	10, 757	8, 589	−15. 1
Current graduates [1]	2, 132	2, 093	2, 043	−4. 2
Upgraded personnel	2, 885	3, 241	2, 283	−20. 9
Experienced technicians	5, 097	5, 423	4, 272	−16. 2

[1] Covers graduates of technical institutes; technical institute education defined in the survey as a 2-year post-high-school program of technical training which may lead to an associate degree.

NOTE.—Figures represent totals for the surveyed employers only, not for all employers in industry and government.

Source: Engineers Joint Council, Engineering Manpower Commission, *Demand for Engineers, Physical Scientists, and Technicians—1964.*

October issue of the *Journal of College Placement.* The information made available from the survey is based on the numbers actually hired as reported by the respondents.

The report contains information from employers on requirements and acceptances for both technical and nontechnical graduates as well as data showing unfilled needs for personnel. All such information is provided by type of employer and by degree and curriculum. A forecast of the next year's requirements is also shown.

The report on the 1962–63 recruiting survey contained recruiting information from 274 responding business, industrial, and governmental organizations showing the following requirements and acceptances:

Personnel	*Number of employers recruiting*	*Number of anticipated requirements*	*Number of acceptances as of July 1, 1963*	*Percent of original requirements filled*	*Number still needed July 1, 1963*
Technical	225	15, 792	12, 618	79. 8	3, 076
Nontechnical	215	10, 172	8, 827	86. 8	1, 456

Not only were technical personnel in greater demand than nontechnical personnel, but employers were also less able to fill all their needs for technical personnel than for nontechnical.

Forecasts of 1963–64 requirements of employers for technical personnel in selected industries are also shown. (See table VI–4.) For most of the selected industries shown, employers responding to this survey anticipated a decline in requirements although still indicating a need for substantial numbers. It should be stressed again that there is no way of determining from the survey results whether these employers are representative of others in the same industry.

Northwestern University Placement Surveys

For the past 18 years, the Northwestern University Placement office has been conducting surveys of anticipated employment of college and university graduates in business and industry. The surveys are conducted in November and the findings relate to anticipated needs for June graduates. The 205 companies which responded to the 1963 survey were for the most part large- and

TABLE VI–3.—*Engineers and physical scientists in actual and projected employment, 1962–65*

Personnel	Number of organizations	Number employed			Percent increase	
		December 1962 (actual)	December 1963 (actual)	1965 (projected)	1962 to 1963	1963 to 1965
Engineers	460	204, 398	212, 782	224, 337	4. 1	5. 4
Physical scientists	200	40, 491	42, 554	46, 333	5. 1	8. 9

Source: Engineers Joint Council, Engineering Manpower Commission, *Demand for Engineers, Physical Scientists, and Technicians—1964.*

TABLE VI–4.—*Comparison of technical personnel in selected industries, 1962–63 and estimated 1963–64 requirements*

Industry	Number of employers reporting	1962-63 requirements	Estimated 1963-64 requirements	Percent change
Aircraft and aerospace	7	1, 566	1, 341	−14. 4
Automotive	6	1, 356	1, 443	6. 4
Chemical, pharmaceutical, and plastic products	37	2, 418	2, 525	4. 4
Electronics and electrical machinery and equipment	27	3, 060	2, 750	−10. 1
Food and beverage manufacturing	6	121	85	−29. 8
Machinery and heavy equipment	12	455	479	5. 3
Metal and metal products	21	634	638	. 6
Petroleum and allied products	13	627	599	−4. 5
Research	12	1, 543	1, 259	−18. 4
Tire and rubber	4	290	289	−. 3
Utilities	27	379	365	−3. 7

Source: Midwest College Placement Association, "The Annual College Recruiting Survey, 1962–63," *Journal of College Placement*, October 1963.

medium-size companies in retail, manufacturing, trade, various service industries, banks and public utilities, and other miscellaneous kinds of business. Most of the companies included in the survey send recruiters to campuses to seek graduates.

Anticipated needs for personnel reported by the companies are summarized by the number in each field in the report of the survey. The companies also indicated whether their needs are up or down from those of the previous year. The report is mainly concerned with male college graduates, although some brief indication of needs for women graduates was also obtained.

Some indication of demand is also revealed from a comparison of personnel hired the previous year with anticipated requirements for the year surveyed. (See table VI-5.) The reporting companies expected to hire over 25 percent more bachelor's degree engineers and chemists, compared with much smaller numbers of graduates in physics and in mathematics and statistics. However, at the master's degree level, there was an indication of relatively greater needs in all of the aforementioned fields, as the following shows:

Field	Percent increase in master's degree graduates to be hired, 1963 to 1964
Engineering	43
Chemistry	78
Physics	66
Mathematics-statistics	38

TABLE VI-5.—*Employment of new male college graduates with the bachelor's degree, by selected field, 1963 and 1964*

Field	1963 (actual)		1964 (projected)		Percent change in graduates
	Number of companies	Number of graduates	Number of companies	Number of graduates	
Engineering	(1)	5,823	(1)	7,289	25.1
Chemistry	61	361	60	459	27.1
Physics	25	170	25	176	3.5
Mathematics-statistics	57	458	48	489	6.8

[1] Not available because of overlap of companies hiring from different fields of engineering.

Source: Frank S. Endicott, *Trends in Employment of College and University Graduates in Business and Industry, 1964*, 18th Annual Report.

The College Placement Council Salary Surveys

The College Placement Council, Inc., the coordinating agency of the eight regional college placement associations of the United States and Canada, annually conducts a survey of beginning salary offers for college graduates in selected curricula. The offers are reported to the Council by college placement offices in the 107 participating colleges and universities 4 times during the academic year, and a final report is issued shortly after the end of the year. The reports issued by the Council do not include salaries offered by educational institutions or Federal, State, and local government agencies and therefore should not be considered as all-inclusive or representative of all sectors of the economy. However, since the colleges and universities that are included cover about 40 States, the information provides a good indication of the trend in salaries offered in a varied segment of private industry.

Information obtained over a 4-year period, 1961-64, provides data on both the level and trend of beginning salaries for male college graduates in engineering and the sciences as well as for graduates in various nontechnical curricula. This type of data serves not only as an indicator of the overall level of current demand for personnel compared with previous years but also serves to show the relative demand among different types of personnel.

Estimates of starting salaries for male bachelor's degree graduates indicate that the actual salary level has continued to increase over the past 4 years although the rate of growth has generally declined. (See table VI-6.) Among engineering graduates, for example, those in aeronautical and electrical engineering have maintained their lead in the level of average dollar offers, but the rate of increase during the past 2 years has been smaller than shown for other engineering fields. In the physical sciences and mathematics, areas in which there has appeared to be a fairly substantial demand for personnel in recent years, the annual rate of salary increases in offers to new bachelor's degree graduates has been smaller than for any of the other fields shown.

Interestingly, a comparison of technical with nontechnical graduate salary offers shows that whereas those in nontechnical fields have consistently received lower average dollar offers, their rate of increase has been greater. However, the actual dollar spread between the technical and nontechnical fields has remained fairly constant for the 4 years shown. According to the College Placement Council, the 3-percent increase for the

TABLE VI-6.—*Estimated average monthly salary offers to male bachelor's degree graduates, by selected curriculums, 1960–61 to 1963–64*

Curriculum	1960–61	1961–62	1962–63	1963–64 [1]	Percent change		
					1960–61 to 1961–62	1961–62 to 1962–63	1962–63 to 1963–64
Engineering:							
Aeronautical	$556	$584	$606	$626	5.0	3.8	3.3
Chemical	541	563	588	614	4.1	4.4	4.4
Civil	514	538	569	594	4.7	5.8	4.4
Electrical	556	583	607	623	4.9	4.1	2.6
Industrial	523	554	577	600	5.9	4.2	4.0
Mechanical	542	564	592	612	4.1	5.0	3.4
Liberal arts and biological sciences	440	464	479	499	5.5	3.2	4.2
Liberal arts	(2)	(2)	479				
Biological sciences	(2)	(2)	483				
Physical sciences and mathematics	537	557	573	588	3.7	2.9	2.6
Chemistry	(2)	(2)	559				
Physics	(2)	(2)	595				
Other physical sciences	(2)	(2)	541				
Mathematics	(2)	(2)	565				
Technical	546	570	595	613	4.4	4.4	3.0
Nontechnical	452	476	500	516	5.3	5.0	3.2

[1] Preliminary estimate.
[2] Not available.

Sources: The College Placement Council, Inc., *Salary Survey, 1962–63 Recruiting Year, Final Report, June 1963;* and, "Runaway Salaries for New College Graduates Fail To Materialize," news release, May 19, 1964.

academic year ending June 1964 is the smallest for technical graduates in any year since the CPC surveys were undertaken in 1959–60.[2]

Estimating Long-Range Demand

Long-range projections of population, labor force, and total employment have been undertaken by both Government and non-Government sources for more than a decade. Only in the recent past, however, has concern for the Nation's future requirements for scientific and technical personnel resulted in intensive theoretical discussions as well as actual attempts to develop meaningful methodologies for estimating such demand. Regardless of the methods used, a number of problems not only impinge on other types of surveys or studies of scientific manpower, but also become magnified in dealing with the area of future demand. Several of the more notable difficulties include: the lack of agreement or precision in defining occupational boundaries; the lack of comparable data on the employment of scientific and engineering manpower for a sufficiently long period of time; the problems involved in projecting various economic factors (e.g., R&D expenditures), which may affect directly the employment of scientific and engineering manpower; and difficulties involved in determining to what extent new or developing technological factors might affect the utilization of scientific and engineering manpower.

One approach which has been used to forecast long-run as well as short-run demand involves surveying a sample of employers in different sectors of the economy to obtain estimates of their future requirements for, or employment levels of, scientists, engineers, and technicians. Generally, employers are requested to fill out mail questionnaires stating how many engineers and scientists are currently employed, how many new employees they expect to hire, and the total number of scientific and technical personnel they expect to

[2] College Placement Council, Inc., "Runaway Salaries for New Graduates Fail To Materialize," news release, May 19, 1964.

have employed at some future date—3, 5, or 10 years in the future. A 1964 survey of this type was conducted by the Engineers Joint Council, referred to previously in the section dealing with short-term indicators.[3] Employers (industry and government) responding to this survey estimated a growth of 26 percent for engineers and 34 percent for physical scientists over the decade 1964–73. Although this method has the advantage of calling upon each employer's knowledge of the situation in his organization and its future plans, it has been found that relatively few employers (including many of the largest ones) have made personnel projections on a formal basis for more than a few years ahead. Furthermore, such estimates are made independently of each other and are likely to be based on varying assumptions and methodologies.

A second method, based on past trends, involves direct extrapolation of the ratio between total population and the number of persons in scientific and technical occupations. Based on future population estimates, the demand estimate for scientists and engineers may be obtained by projecting the current ratio to a future date. A corollary approach would be to simply extrapolate the trends shown by past data on scientific and engineering employment. The logic of this approach is questionable since it does not appear to take into account the complex changing developments which may be occurring in different sectors of the economy and affecting the future demand for the services of scientific manpower.

Estimates of future requirements also may be derived from a number of other economic variables such as changes in the gross national product, research and development expenditures, and levels of production. Although projections of the past relationship between GNP and the numbers of personnel in scientific and technical occupations are a fairly simple matter, such estimates tend to ignore the underlying factors of a dynamic situation. Utilization of the relationships between research and development activities (as measured by expenditures) and personnel engaged in such functions may provide a better fix on demand in this particular area. However, in this latter case, not only are there gaps in personnel data but, as mentioned previously, very little work has been undertaken to forecast R&D expenditures in different economic sectors.

The most recent attempts to develop a comprehensive methodology were undertaken by the Bureau of Labor Statistics for the National Science Foundation.[4] What has been labeled a "segmental method" was employed to derive an estimate for the economy as a whole. This approach required a careful examination of the scientific and technical personnel employment trends within each economic sector—private industry (by each industrial segment), government (at the Federal, State, and local levels), colleges and universities, nonprofit organizations, and any other segment not specifically classified—and, wherever possible, an analysis of the various factors underlying these trends. Certain general assumptions were made regarding the future economic structure of the United States as well as other economic and social phenomena. Projections of the total population, the total labor force, and gross national product were made to 1970. Projections of total employment in each economic sector were then developed; and, on the basis of past trends in the ratio of scientific and technical personnel to total employment, extrapolations of these personnel ratios resulted in approximations of employment of scientific and technical manpower expected in 1970. In addition, an intensive investigation of the validity of these projections was undertaken in several industries through a large number of interviews with high-level officials in major companies and an analysis of published and unpublished data pertaining to employment, R&D expenditures, possible new product developments, etc. These additional steps resulted in a further review of the original projections and, in some cases, modifications of the employment estimates. The most recent estimates, based on a completed study in 1962, indicate a 10-year increase of almost 70 percent in the number of scientists and engineers required over 1960 levels—bringing the employment level of these personnel to slightly under 2 million in 1970.

[3] Engineers Joint Council, Engineering Manpower Commission, *Demand for Engineers, Physical Scientists, and Technicians—1964*, July 1964.

[4] See National Science Foundation, *The Long-Range Demand for Scientific and Technical Personnel—A Methodological Study*, NSF 61-65, and *Scientists, Engineers, and Technicians in the 1960's—Requirements and Supply*, NSF 63-34.

A final note seems pertinent. As was pointed out in the beginning of this brief chapter, the concept of demand has many facets. In many instances, "demand" and "need" are used interchangeably, and in this regard some caution is necessary. In general, the term "demand" usually means an employment level determined by the market, based on the various economic, social, and institutional forces at work; "need" may signify a judment of what ought to occur for purposes of meeting certain goals in research, education, and professional services for the Nation.

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APPENDICES

APPENDIX A

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APPENDIX B

Organizations Concerned With Scientific and Engineering Manpower Information

This list includes some of the principal Federal agencies and other organizations concerned with scientific and technical manpower information and briefly notes some of their main interests in this area. They are given here to indicate the kinds of pertinent manpower information generated by each of them. The list is by no means a complete enumeration of such organizations or interests, and the activities noted do not necessarily reflect the main functions of these organizations.

FEDERAL GOVERNMENT AGENCIES

ATOMIC ENERGY COMMISSION

Supports salary surveys of R&D personnel.

Supports employment surveys of scientific and technical personnel in atomic energy work.

CIVIL SERVICE COMMISSION

Conducts studies and prepares publications on technical and general personnel.

Makes manpower forecasts for Federal Government employment.

Develops classification and qualifications standards for professional and technical occupations.

Conducts studies and prepares publications on education and training.

DEPARTMENT OF DEFENSE

Helps determine civilian and military manpower needs in professional and technical occupations for carrying out programs of military services.

Conducts studies to determine training needs for professional and technical personnel.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

Office of Education

Undertakes surveys and prepares reports on the following:

- Total enrollments and earned degrees.
- Detailed engineering enrollments and degrees; technical institute enrollments and completions; junior-year enrollments in science, mathematics, and foreign languages; and enrollments for advanced degrees.
- Offerings and enrollments in science and mathematics in public high schools.
- General and specific problems of teacher education.
- College student retention and withdrawal.
- Costs incurred by students in attending college.
- Availability of students financial assistance provided by institutions.

Public Health Service

Cooperates with the National Science Foundation's National Register of Scientific and Technical Personnel to obtain information on personnel characteristics of sanitary engineers.

Makes studies and analyses of manpower needs in the major scientific and engineering disciplines in the field of health.

DEPARTMENT OF LABOR

Bureau of Employment Security

Carries out programs involving:

- Periodic reports on area labor market conditions for scientific and technical personnel.
- Monthly analyses of job openings in interarea clearance.
- Occupational guides for professional personnel, including engineering, science, and other technical occupations.
- Areawide skill surveys which take broad inventories of skills, including professional and technical, in selected communities.

Bureau of Labor Statistics

Carries out programs involving:

- Annual surveys of employment of scientists, engineers, and technicians in industry. Similar data are collected periodically on State and local government agencies and nonprofit institutions.
- Special surveys (e.g., of scientific, engineering, and technician employment in the atomic energy industry).
- Special studies of the long-range demand for and supply of engineers, scientists, and technicians, including estimates and projections for each segment of the civilian economy.
- Publication of guidance material for high school counselors and persons interested in choosing a career, including extensive information on scientists, engineers, and technicians. The *Occupational Outlook Handbook* (revised periodically) is the major BLS publication. Salary surveys of selected occupations (including scientific and technical) to obtain data for comparison with Federal Government salary structure.

Bureau of Apprenticeship and Training

Carries out occasional surveys of training programs in industry covering a broad spectrum of occupations, including scientific and technical personnel.

Office of Manpower, Automation, and Training

Carries out and sponsors research projects on the Nation's manpower requirements and resources (including scientific and technical manpower) to provide information about present and future job opportunities.

Supports studies to evaluate the Nation's manpower training efforts for all types of occupations.

Publishes reports periodically evaluating various aspects of manpower resources and training.

Coordinates the preparation of the annual report of the Secretary of Labor on manpower requirements, resources, use, and training which is submitted to the President as required by the enabling legislation.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Undertakes reorganization of curricula and preparation of textbooks for the aerospace sciences.

Takes part in development of techniques for identifying creative research aptitudes.

Carries out studies to determine future needs for specialized personnel.

NATIONAL SCIENCE FOUNDATION

Maintains the National Register of Scientific and Technical Personnel.

Maintains a "clearinghouse" of information on scientific and technical personnel.

Supports studies and surveys to obtain information on the employment, utilization, training, supply, and demand of scientific and technical personnel, and prepares and publishes reports on studies and surveys.

EXECUTIVE OFFICE OF THE PRESIDENT

White House Office

Federal Council for Science and Technology

Established by Executive order, March 1959, under the chairmanship of the President's Special Assistant for Science and Technology. Membership includes policy-level representatives from departments and agencies with major responsibilities in the research and development field. They include the Departments of Defense, Interior, Agriculture, Commerce, and Health, Education, and Welfare; the National Science Foundation; the National Aeronautics and Space Administration; and the Atomic Energy Commission.

The Council makes studies and calls on other agencies for special evaluations involving areas of its responsibility, including pertinent manpower information. The purpose is to advise the President on problems and developments in the fields of science and technology and related activities affecting more than one Federal agency or concerning the overall advancement of the Nation's science and technology and to recommend policies and other measures which:

Provide more effective planning and administration of Federal scientific and technological programs.

Identify research need.

Achieve more effective utilization of the scientific and technological resources of Federal agencies, and promote international cooperation in science and technology.

Interagency Committee on Oceanography. Has responsibilities for coordinating Federal activities in the marine sciences under the direction of the Federal Council for Science and Technology. Manpower and training information and problems are coordinated through the ICO Panel on Manpower and Training.

Office of Science and Technology

Established in the Executive Office by reorganization in June 1962. The OST conducts studies and generates special reports from other sources on matters, including scientific and technical manpower, pertaining to the coordination of Federal science and technology functions, particularly with respect to:

Major policies, plans, and programs of science and technology of the various agencies of the Federal Government;

Assessment of selected scientific and technical developments and programs in relation to their impact on national policies;

Review, integration, and coordination of major Federal activities in science and technology;

Assuring that good and close relations exist with the Nation's scientific and engineering communities; and

Such other matters consonant with law as may be assigned by the President to the Office.

President's Science Advisory Committee

The Committee (PSAC), reconstituted and transferred to the White House in 1957, has responsibilities to provide answers to questions raised by the President, to undertake assignments for him of an advisory kind, to mobilize the best scientific advice of the country in behalf of the Federal Government, and to recommend ways by which U.S. science and technology can be advanced, especially by the Government, and can best serve the Nation's security and welfare.

The Committee has no operating responsibilities, but is charged broadly with making scientific advice and analyses available when needed in the formulation of national policy. It is responsible for recommending ways whereby the Federal Government can strengthen the Nation's scientific and engineering activities. It serves the important function of providing a communications center for science in the Federal Government, and thus facilitates intercommunication among the various scientific activities within Government and between the Government and the scientific community outside of Government.

NON-GOVERNMENT ORGANIZATIONS

AMERICAN CHEMICAL SOCIETY

Prepares career information booklets.

Conducts annual surveys on beginning salaries of chemist and chemical engineers.

Conducts professional status surveys.

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN ECONOMIC ASSOCIATION

Cooperates, beginning in 1964, with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN GEOLOGICAL INSTITUTE

Conducts annual surveys of geology-geophysics students in the colleges and universities of the United States and Canada.

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN INSTITUTE OF BIOLOGICAL SCIENCES

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN INSTITUTE OF PHYSICS

Collects and publishes statistical information about manpower and education in physics.

Surveys physics graduate students for background information.

Publishes the *Directory of Academic Physics Departments*, which contains data on faculty.

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN MATHEMATICAL SOCIETY

Conducts salary surveys of mathematicians in colleges and universities.

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Answers questions about occupations in engineering (and engineering technician) as a career.

Prepares analyses of technical institute and engineering enrollments.

AMERICAN METEOROLOGICAL SOCIETY

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN PSYCHOLOGICAL ASSOCIATION

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

AMERICAN SOCIOLOGICAL ASSOCIATION

Cooperates, beginning in 1964, with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

ENGINEERS JOINT COUNCIL-ENGINEERING MANPOWER COMMISSION

Gathers and disseminates information of supply, demand, and utilization (e.g., studies of salary and income, demand for engineers, placement of graduates, enrollments and degrees).

Takes action on manpower problems and recommends policies for government, industry, and the profession (e.g., critical skills program, increased recognition and utilization of engineering technicians, government contract procedures).

Informs the public, teachers, and future engineers of the role of engineers in the national economy, security, and general welfare (e.g., guidance in high schools, and publication, jointly with Scientific Manpower Commission, of the *Engineering and Scientific Manpower Newsletter*).

Cooperates, beginning in 1964, with the National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

FEDERATION OF AMERICAN SOCIETIES FOR EXPERIMENTAL BIOLOGY

Cooperates with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

MODERN LANGUAGE ASSOCIATION OF AMERICA, CENTER FOR APPLIED LINGUISTICS

Cooperates, beginning in 1964, with National Science Foundation's National Register of Scientific and Technical Personnel to obtain personnel characteristics information.

NATIONAL ACADEMY OF SCIENCES-NATIONAL RESEARCH COUNCIL

Maintains list of doctorates, by field, awarded each year.

Maintains a current file of persons receiving doctorates from American colleges and universities.

NATIONAL EDUCATION ASSOCIATION

Conducts surveys and prepares reports for the following:

Secondary schools. Annual national teacher supply and demand reports, including numbers of eligible college graduates for teaching, occupations entered by eligible graduates for teaching, numbers and sources of new teachers, and distributions of new teachers among teaching fields.

Universities, colleges, and junior colleges. Biennial national teacher supply and demand reports, including numbers of new teachers, by field; sources of new teachers; and academic preparation of new teachers.

Occupations entered by doctor's degree recipients.

NATIONAL SCIENCE TEACHERS ASSOCIATION

Compiles a U.S. Registry of Science and Mathematics Teachers.

Undertakes surveys to determine qualifications of secondary school teachers of science and mathematics.

NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Sponsors surveys and studies by the Professional Engineers Conference Board for Industry on utilization, training, recruitment, and retention of engineering personnel, and improvement of engineer-management communications.

Conducts income surveys of membership.

Conducts studies on status of profession.

Conducts studies and surveys of secondary school curricula to determine adequacy of high school preparation for study of engineering in college.

SCIENTIFIC MANPOWER COMMISSION

Collects and analyzes statistical data on demand, supply, trends, employment outlook, and salaries.

Publishes a bulletin, *SM Comments*, containing highlights of current programs and reports prepared by Government and nongovernment organizations pertaining to scientific and technical education and manpower, and summaries of proposed or completed legislation by Congress affecting these areas.

Publishes, jointly with the Engineering Manpower Commission, the *Engineering and Scientific Manpower Newsletter*.

APPENDIX C

Subject Index

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U.S. GOVERNMENT PRINTING OFFICE : 1965 O—693-250